National Park Service Inventory and Monitoring Program

A Summary of the Coastal and Barrier Network Monitoring Workshop

April 13th and 14th, 2000

Introduction

Preserving the natural resources and processes in the National Parks may be the most important legacy the Park Service can provide American conservation. Probably no ecosystem on earth remains totally unaffected by modern human activities. But, in a world in which natural places have become few and precious, knowledge of the composition and function of relatively unaltered natural systems is invaluable. This especially applies to the National Park Service. Knowing the condition of natural resources in national parks is fundamental to the National Park Service's ability to protect and manage its parks. In response to this need, congress passed the National Parks Omnibus Management Act in 1998, increasing funding to the already established Inventory and Monitoring Program (I&M program) of the National Park Service. The I&M program was created to establish park inventories to collect baseline information and to provide information on the long-term trends in the condition of National Park System resources through monitoring.

Today, National Park resource managers across the country are confronted with increasingly complex and challenging issues. They are increasingly being asked to provide credible, scientific data to defend their management actions. One objective of the I&M program is to enable managers to make better informed management decisions (Silsbee et al, 1995). As part of the I&M program, long-term monitoring will provide an ongoing assessment that tracks the condition of the resources and identifies the threats to their integrity (Peterson et al, 1995). The overall purpose of NPS I&M monitoring program will be to develop broadly based, scientifically sound information on the current status and long term trends in the composition, structure, and function of a park's ecosystem. Use of this information will not only help to increase confidence in park management decisions, but improve on the ability of the Park Service to manage it's natural resources.

Ecosystem Monitoring

The task of developing a long-term monitoring program to detect and recognize significant change is complex. Natural systems are inherently dynamic and spatially heterogeneous. Further, many changes in space and time are not a consequence of human-induced actions, and many are not amenable to management intervention. In general, monitoring data are intended to detect long-term environmental change, provide insights to the ecological consequences of these changes, and to help decision makers determine if the observed changes dictate a correction to management practices (Noon et al, 1999). A monitoring program should address not only today's resource problems, but also the need for information to anticipate and define future resource problems. Therefore, ecosystem monitoring is conducted primarily for two purposes: (1) to detect significant changes in resource abundance, condition, population structure, or ecological processes; or (2) to determine the effects of some management action on population or community dynamics or ecological processes.

The first step in developing a long-term monitoring program is to articulate clearly the management goals and objectives of the park-specific program in concert with regional and servicewide goals and objectives. The overall goal of natural resource monitoring in parks is to develop scientifically sound information on the current status and long term trends in the composition, structure, and function of park ecosystems, and to determine how well current management practices are sustaining those ecosystems. In order to be effective, monitoring objectives should be realistic, specific, unambiguous, and measurable and include the following six components to be complete (Elzinga et al. 1998):

- the indicator to be monitored
- the location or geographical area
- the attribute of the indicator to be measured (e.g., population size, density, percent cover)
- the intended management action (increase, decrease, maintain)
- the measurable state or degree of change for the attribute
- the time frame

A number of criteria are critical to the design of a successful monitoring program:

- The same methods or protocols should be used to take measurements over time.

- The monitoring program should be designed for a specific purpose, usually to determine progress toward a management objective.

- And some action should be taken based on the results, even if the action is to maintain the current management.

To meet these criteria, the NPS I&M Monitoring Program must:

- Be relevant to current management issues as well as anticipate future issues based on current and potential threats to park resources.

- Be scientifically credible.

- Produce data of known quality that is accessible to managers and researchers and provided in a timely manner.

- Have an explicit link to management decision-making.

Network Description

In order to reduce costs and increase efficiency, the NPS has clustered parks into networks. These networks consist of parks that exist within similar ecoregions. This method of clustering parks allows strategies for inventory and monitoring to be developed across networks rather than individual parks. It also allows the possibility of data acquisition to occur across several locations simultaneously. It requires sharing of staff and resources, cooperation and assistance within the network and in some cases between networks where data collection and analysis needs overlap (example: Acadia NP, Coastal and Barrier parks and southeast barrier island parks).

The Coastal and Barrier Network contains eight National Park Service sites in five states, extending from the Cape Cod National Seashore in Massachusetts to the Colonial National Historical Park in Virginia (Table 1). These parks represent some of the most ecologically similar collections of lands within the Park Service. They consist of critical coastal habitat for many rare and endangered species, as well as migratory corridors for birds, sea turtles and marine mammals. They also protect vital coastal wetlands, essential to water quality, fisheries, and the biological diversity of coastal, nearshore,

and terrestrial environments. Key components in developing a structured monitoring program for the network, include data collection, information management, preparation of data summaries and interpretive reports, feedback to management, and program coordination and support.

Table 1. Park Members of the Coastal and Barrier Network.

Park Name	Code	Location	Acreage
Assateague Island National Seashore	ASIS	MD,VA	48,000
Cape Cod National Seashore	CACO	MA	43,604
Gateway National Recreation Area	GATE	NY, NJ	26,610
Fire Island National Seashore	FIIS	NY	19,580
Colonial National Historical Park	COLO	VA	9,350
George Washington's Birth Place National Monument	GEWA	VA	550
Thomas Stone National Historic Site	THST	MD	322
Sagamore Hill National Historic Site	SAHI	NY	83

Developing a Monitoring Program for the Coastal and Barrier Network

Steps towards Developing a Monitoring Strategy

Seven steps have been recommended in the development of long-term monitoring programs within park networks. They include:

1. Forming a steering committee.
2. Summarizing existing data and understanding.
3. Preparing for and holding a scoping workshop.
4. Writing a report on the workshop and having it widely reviewed.
5. Holding a meeting to decide on priorities and implementing approaches.
6. Drafting the monitoring strategy.
7. Review and approval of the monitoring strategy.

Workshop Preparation

The Steering Committee

In order to develop a monitoring strategy for the Coastal and Barrier Network, a steering Committee has been established (Appendix A Table 1). Decisions regarding the development and implementation of a monitoring strategy, including decisions on hiring, budgeting, scheduling, and promoting accountability for the monitoring program are issues to be addressed by the committee. Before the scoping workshop was held, the committee met to help develop a workshop agenda, by identifying and prioritizing management issues, identifying representative ecosystems existing within the network parks and developing monitoring questions.

In order to structure a monitoring program that could encompass all eight parks within the Coastal and Barrier Network, representative ecosystems were identified. Based upon the long-term "prototype" monitoring program at the Cape Cod National Seashore, the steering committee identified four ecosystems existing across parks that could be used as a basis for discussing specific monitoring issues. These include:

1. Estuaries and near shore environment

2. Freshwater wetlands, pond and streams
3. Uplands (forests, grasslands and thickets)
4. Beaches, dunes, spits and shoreline systems

Based upon prior input from the parks, the steering committee then selected high priority management issues relevant to all the Coastal and Barrier parks:

- Shoreline Change
- Water Quality
- Species and Habitats of Concern
- Resource Extraction
- Recreation and Visitor Use

The steering committee then proposed monitoring questions and identified candidate Indicators or "Vital Signs" for each Management Issue based largely on the Cape Cod National Seashore prototype (Appendix B Document I). Vital signs are indicators of the key ecological processes, which, collectively, capture the function of a healthy ecosystem. They represent early warning signs of ecosystem stress, ideally before significant damage has occurred, and point to the need for intensive studies to diagnose the cause of the stress and determine appropriate corrective action. They may include keystone species and keystone habitats, which have profound effects on ecosystem organization and function; dominant species; or key processes such as nutrient cycling, shoreline dynamics, or hydrologic regimes. Aquatic species populations, nutrient and contaminant input, and water table level are just a few examples of "vital signs", broadly applicable and relevant to most Coastal and Barrier Network Parks (Table 2).

Table 2. Characteristics of the ideal "Vital Sign".

• have ***dynamics*** that parallel those of the ecosystem or component of interest; • are ***anticipatory***: they signal degradation before serious harm has occurred; • are ***sensitive enough*** (or broadly applicable to many stressors) to provide an early warning of change; • have a ***high "signal to noise",*** are relatively insensitive to factors other than the stressor; • provide a ***continuous assessment*** over a wide range of impacts; • have ***dynamics*** that are easily attributed to either natural cycles OR anthropogenic sources; • are ***distributed*** over a wide geographical area and/or are very numerous; • can be **accurately** and ***precisely estimated***; • have ***low natural* variability**; • have ***known variability*** and other statistical properties so criteria for being "out of range" are known;	• are at an appropriate ***scale***; • are ***constant*** during the period of measurement; • are ***easy to* measure**, ***time*** and ***cost effective*** and ***standard protocols*** are available; • are ***related*** to ecosystem condition in a way that can be ***interpreted*** and ***explained***, there is a clear ***connection*** between the indicator and the function it reflects; • are ***low impact*** or ***non-destructive*** to measure and; • have ***measurable results*** that are repeatable/consistent with different observers; • are ***timely*** and provide information quickly enough to react; • are ***unique*** and ***do not duplicate*** other indicators; • can be ***communicated*** to managers and the public; • are ***socially* relevant** and ***politically appealing***: people care about the indicator.

Park Contributions to the Workshop
Prior to the workshop, each resource manager was asked to provide a description of their park and resources as well as provide: the following: (Appendix B Document IV)

1. A list of species and habitats of concern.
2. A list of species/resources extracted from the park by hunting, fishing, poaching, groundwater removal, sand, crops, etc…and the habitats impacted by removal.
3. A list of fully operational, ongoing monitoring programs.
4. A list of additional management issues not included in the list created by the steering committee.

Workshop Participants
Workshop participants were selected based on knowledge of park resources and issues in the Coastal and Barrier Network and/or scientific expertise relevant to selected ecosystems (Appendix A Table 2). Some of those who were invited to the workshop, but were unable to attend agreed to review the workshop report (Appendix A Table 3). Prior to the scoping workshop, prospective participants were sent a briefing packet of reading material to 1) explain the purpose of the NPS I&M Program and the scoping workshop and 2) provide a conceptual background for planning monitoring strategy (Table 3; Appendix B).

Table 3. Coastal and Barrier Network I&M Workshop: Monitoring Briefing Materials.

▪ Vital Signs Workshop Agenda and description of workshop format, as well as product examples to be created during the workshop. ▪ A list of management issues in coastal and barrier parks. ▪ A summary of a workshop held by the Patuxent Wildlife Research Center on coastal issues. ▪ Description of Coastal and Barrier Network Parks resources and settings, including responses to questions listed above. ▪ Conceptual framework for the development of long-term monitoring protocols at Cape Cod National Seashore. ▪ GIS layers available for each park.

The Scoping Workshop

Workgroups
During the scoping workshop, participants were divided into five workgroups based on the five management issues identified by the steering committee; shoreline change, water quality, species and habitats of concern, resource extraction and recreation and visitor use (Appendix A Table 4). Each group was directed by a leader, who guided the group through discussion and completion of the vital signs templates for each indicator addressed, and the completion of the workgroup summary sheet

Following this scoping workshop, the workgroups were asked to write a report on the results of their workgroup discussions and send it to the I&M Coordinator to be included in this report. So far we have

received four out of five reports, and have requested the final one for Resource Extraction. The following is a summary of what was discussed and identified for monitoring by the five workgroups. A complete copy of the reports can be found in Appendix C Documents I-V.

Water Quality

The workgroup created a list of what they considered the most significant threats to water quality in the Coastal and Barrier Network (Tables 4 & 5). They suggest that a monitoring program's minimum capabilities be to detect a change in park ecosystems relative to these threats. The group also developed three broad monitoring questions during the workshop (listed below). Candidate vital signs with potential for providing answers to these monitoring questions were then identified (summarized in Table 4).

1. Is water quality changing outside the bounds of natural variability?

2. Does changing water quality impact natural and cultural resources and visitor use?

3. What are the causes of changes in water quality?

The group then addressed and prioritized vital signs for these monitoring questions as well as measurement parameters. (Table 5).

Table 4. Water quality stressors identified by the workgroup.

Threats/Stressors	Categories of Candidate Vital Signs
Eutrophication (including harmful algae blooms)	▪ Autotrophic production ▪ Community composition/distribution ▪ Ecosystem metabolism ▪ Nutrient load ▪ Watershed characteristics ▪ Nutrient Sources
Contaminants (including toxics, bacterial contamination, marine debris, and sediments)	▪ Contaminant concentration change ▪ Light attenuation change ▪ Acute or chronic responses in aquatic flora and fauna communities. ▪ Sources of contaminant input ▪ Physical processes influencing bioavailability of contaminants
Hydrologic Alterations (including tidal restriction, groundwater withdrawal, saltwater intrusion)	▪ Surface and groundwater level ▪ Water chemistry ▪ Community composition, distribution, and production ▪ Ecosystem metabolism
Acidification	▪ pH and water chemistry ▪ Acid Neutralizing Capacity ▪ Ecosystem metabolism ▪ Responses by terrestrial vegetation and cultural resources

Table 5. The top ranked water quality vital signs identified by the Water Quality Workgroup.

Ranked Vital Signs	Resource	Measurement Parameters	Sampling Frequency
1. Basic Water Quality	Estuaries Nearshore environments Freshwater wetlands Ponds Streams	Temperature Salinity (salt water) Electrical conductivity (freshwater) Dissolved oxygen (to include diel depth profiling as needed to determine the depth and duration of hypoxia/anoxia) Total Nitrogen, Phosphorus pH Acid Neutralizing Capacity Depth Turbidity/% light transmission Total water column chlorophyll a Total suspended solids Fecal-Indicator Bacteria	Monthly or less with additional event sampling
2. Land Use/Land Cover/Vegetation Mapping	Estuaries Nearshore environments Freshwater wetlands Ponds Streams	Watersheds within and outside park boundaries Distribution of major vegetation types (including submerged aquatic vegetation and potentially macroalgae)	Aerial photographs acquired and interpreted, with ground truthing, every 2-5 years.
3. Fauna	Estuaries Nearshore environments Freshwater wetlands Ponds Streams	Species richness Distribution and abundance of macroinvertebrates in saltwater environments (The value of fish should be reviewed as a potential faunal indicator instead of or in addition to macroinverts)	
4. Surface and groundwater levels	Estuaries Nearshore environments Freshwater wetlands Ponds Streams Uplands Beaches Dunes Spits Shoreline systems	Distribution and connectedness of surface waters (including seasonal and tidal components of surface water cover and depth) Precipitation (quantity) Groundwater chemistry (annually)	
5. Water Column-Sediment Toxicity	Estuaries Nearshore environments Freshwater wetlands Ponds Streams Uplands Beaches Dunes Spits Shoreline systems	Bioassays using macroinvertebrates Tissue residues in fish and shellfish Sediment chemistry	
6. Amphibian distr. and abundance	freshwater wetlands, ponds and streams		

<u>Shoreline Change</u> ("Shore Zone" Change)

Development of monitoring questions requires the identification of key management issues within the network. The shoreline change workgroup collectively agreed that one of the fundamental problems facing resource managers in coastal or barrier parks is the spatial patterns of loss or gain of land due to shoreline change. Coastal parks such as Assateague Island, Fire Island and Gateway need to monitor shoreline changes to better understand and predict the effects of this fundamental attribute. The Chesapeake Bay parks such as COLO and GEWA have similar land loss issues. Shoreline changes, resulting from a combination of natural coastal processes and processes altered by human manipulation of shorelines or sediment supplies, can have profound effects on natural resources, habitats and the built and historic environment, both cultural and archaeological resources and visitor facilities. For example, the process of shoreline change directly affects dune and vegetation patterns, which in turn, determine the availability of critical habitat for threatened species such as the piping plover and seabeach amaranth. Better information on shoreline change also reduces the long-term costs of facility management by identifying those areas least suitable for development. Protection of cultural resources depends on knowledge of shoreline change. A general monitoring question pertaining to shoreline change was developed by the workgroup as well as three basic vital signs or indicators of change (Table 6).

The workgroup then made recommendations for the design and implementation of a Monitoring Program for Shoreline Change. Their recommendations are as follows:

1. The three methods suggested for implementation of a monitoring program are available at all space and time scales deemed necessary and affordable.
2. The NPS should be careful not to duplicate efforts to train staff and purchase equipment.
3. A coordinator should be hired by the NPS I&M Program to lead the monitoring effort. Requirements for this person should include:
    - Skilled in data gathering and analysis
    - Required to support all coastal parks when and where needed
    - Required to oversee park staff's field surveys fulfillments
    - Stationed regionally, but University based in order to make use of new advances in technology and methodology

Table 6. Spatial and temporal coastal change monitoring questions, vital signs and methods.

Monitoring Question: What is the spatial and temporal variation of the frequencies and magnitudes of coastal change?		
Vital signs/indicators	**Methods**	**Measurements**
▪ Shoreline position ▪ Temporal variability (mean high water) ▪ Spatial variability ("fetch-limited" shorelines)	▪ Aerial imagery ▪ GIS oriented data ▪ 2-D or 3-D Field surveys	▪ Profile transects
▪ Landward limit of shore zone change	▪ Aerial imagery ▪ GIS oriented data ▪ 2-D or 3-D Field surveys	
▪ Elevational change data characteristics of the coastal topographic envelope of concern	▪ Airborne topographic mapping	▪ Rate of loss of uplands

Recreation and Visitor Use

The key management issue identified by the workgroup as affecting all Coastal and Barrier Network parks is:

- The threat of increased visitor use and recreational activities on the quality of park resources and visitor experiences.

The workgroup then developed two monitoring questions based on this management issue as well as indicators and methods of indicator measurement (Table 7).

- How are the type, amount, and distribution of visitor uses changing over time?

- What type and extent of resource degradation is occurring?

Table 7. Recreation and visitor use monitoring questions, vital signs and methods.

Monitoring Question: How are the type, amount, and distribution of visitor uses changing over time?		
	Vital Signs	**Methods**
Measure of visitor use	▪ Type of recreation use ▪ Amount of recreation use ▪ Distribution of recreation use	▪ Management workshop to ID and map ▪ Direct observation from selected sample points ▪ Park use assessment methods (entry point questions/counts, parking lot counts) ▪ Aerial surveys for selected use types (e.g. boats, ORV's)
Monitoring Question: What type and extent of resource degradation is occurring?		
	Vital Signs	**Methods**
Effects on Vegetation	▪ Vegetation loss ▪ Vegetation compositional change ▪ Unintended trail proliferation ▪ Unintended recreation site proliferation ▪ Substrate erosion	▪ Aerial photography ▪ Vegetation sampling along trails and recreation sites
Effects on wildlife	▪ Disturbance time ▪ Road kills ▪ Attraction behavior	▪ Direct observation ▪ Road segment sampling ▪ Observation of visitor WL feeding ▪ Observation of WL attraction ▪ behavior
Effects on water resources	▪ Water turbidity ▪ Biological contamination	▪ Sampling at recreation sites and paired controls

Species and Habitats of Concern

This workgroup focused specifically on non-native and invasive species, rare, threatened and endangered species, and habitats and communities of special significance (Table 8).

Monitoring questions developed by the workgroup:

- What are the changing trends of exotic and invasive species (frequency, abundance, and distribution)?
- What factors are contributing to exotic species?
- What are the effects of exotic/invasive species on Park resources?
- What are the changing trends in rare species (frequency, abundance, and distribution)?
- What are the changes in species [diversity] composition of major habitats?
- What are the changes in spatial distribution and abundance of major vegetation communities (mapping) i.e., communities of concern?
- What are the changing trends in featured species (deer, horses)?
- What is the rate of change in adjacent land use?

Table 8. Species and Habitats of Concern monitoring questions, vital signs and methods.

Monitoring Question	Vital Signs	Measurements/Methods
What are the changing trends of exotic and invasive species?	▪ Distribution of invasive species ▪ Change in abundance of exotic species ▪ Abund. of epiphytic algae in eelgrass beds	▪ Mapping intervals ▪ Permanent plots establish and revisit
What factors are contributing to exotic species expansion?	▪ Adjacent land use rate of change ▪ Human use patterns/change ▪ Soil disturbance	▪ % forest cover ▪ Density of homes ▪ Miles of road ▪ Land use classification
What are the effects of exotic/invasive species on Park resources?	▪ Trend of Exotics ▪ Featured species (e.g., deer, ponies) ▪ Distribution of other species ▪ Reproduction of other species	▪ Frequency ▪ Abundance ▪ Distribution ▪ Demographics
What are the changing trends of rare species?	▪ Population status ▪ Abundance and distribution of rare species ▪ Community status	▪ Distribution ▪ Abundance ▪ Recovery Plan Goals (metrics)
What are the changes in species composition & diversity in major habitats?	▪ Vegetation ▪ Native freshwater fish ▪ Amphibians ▪ Migratory bird ▪ Small mammals ▪ Changes in Park resource composition	▪ population turnover ▪ reproductive success ▪ species richness/diversity ▪ predation rates ▪ nesting trends ▪ distribution and abundance
What are the changes in spatial distribution and abundance of major vegetation communities?	▪ Abundance and distribution of community types	▪ Mapping

Resource Extraction

Resource extraction involves species and activities that are seasonal or transient in the parks. It involves shell fishing, fishing, hunting, poaching, groundwater withdrawal, collecting, harvesting, dredging, etc… Eight Resource Extraction issues were identified by the workgroup:

1. Finfishing (all parks)
2. Shellfishing (all parks)
3. Groundwater Extraction for Potable Water and Irrigation (CACO)

4. Sand Mining (ASIS)
5. Channel Dredging (GATE)
6. Hunting (most parks)
7. Recreatonal Collecting-mushrooms, shells, butterflies, herps, etc. (not identified as a major issue in any of the Network parks)
8. Surface Water Extraction (COLO)

From this list a "stressor/response table" was created (Table 9).

Table 9. Stressors/Responses identified by the Resource Extraction workgroup.

Threat	**Stressor**	**Response**
Shellfish Extraction (commercial and recreational)	Bottom disturbance	Decline in biodiversity Degraded water quality Recreation impact
Finfish Extraction	Loss of predation	Decline in biodiversity Degraded water quality Recreational impact
Hunting/Collecting	Decline in species #'s (mushrooms, butterflies, deer, plants)	Impact on decomposition Impact on pollination Decline in biodiversity
Groundwater Extraction	Change in water table Nutrient loading Increased salinity in groundwater	Increased salinity Change in plant/animal species Increased contaminant delivery to system
Sand Extraction	Change in littoral drift Change in shoreline dynamics	Change in shoreline (beach retreat) Change in shoreline bathemetry
Muck Extraction (Dredging)	Resuspension of contaminated sediment. Change in hydrography and sediment suspension budget	Erosion Contaminant redistribution Change in light penetration Change in benthic diversity

The workgroup decided upon and prioritized what they felt were the top three monitoring questions based upon the impacts Resource Extraction has on park resources. They then identified a vital sign for each of the three monitoring questions as well as identified ecosystems affected and justification for why the vital sign was chosen.

Monitoring Question:
What are the effects of groundwater extraction on water tables (very significant), uplands, estuaries, wetlands and surface water availability?

Vital Sign:
Changes in water table and salinity that differ from natural patterns of variation.

Ecosystem this Vital Sign applies to: Freshwater Wetlands: ponds, streams, Uplands: forest, grasslands, thickets

Justification for choosing this vital sign:

* Easy to measure
* In many cases has been measured for a long period of time and has known variability
* Measurement is nondestructive
* Can be communicated to managers and to the public

Monitoring Question:
How does coastal sand mining effect hydrography (residence time, wave climate, loss of shoals, sediment budget)?What is the frequency and intensity of sand dredging?

Vital Sign:
Bathymetry, shoreline change through GIS

Ecosystem this Vital Sign applies to: Beaches, dunes, spits, shoreline systems

Justification for choosing this vital sign:
* Meets almost all the features of an ideal indicator.
* It is anticipatory and non-destructive to measure.

Monitoring Question:
What are the effects of commercial and recreational shellfish harvesting on park aquatic habitats?

Vital Sign:
Some measure of habitat disturbance to bottom habitat and associated communities (set up a control area (refuge) within the park for comparisons)

Ecosystem this Vital Sign applies to: Estuaries and Near Shore Environments

Justification for choosing this vital sign:
* The effect is monitorable
* Information can be used to justify a management action

Other information:
* Need to determine "threshold" values for disturbance
* Need inventory of state regulations describing allowable gear types
* Need to develop cause/effect relationship data describing disturbance per unit effort

Summary of Monitoring Questions Developed During the Workshop
Below is a complete list of monitoring questions developed during the workshop for the Coastal and Barrier Network

- ♦ Is water quality changing outside the bounds of natural variability?
- ♦ Does changing water quality impact natural and cultural resources and visitor use?
- ♦ What are the causes of water quality change?
- ♦ What is the spatial and temporal variation of the frequencies and magnitudes of coastal change?

- What are the changes in visitor use over time? (types, amounts, and distribution)
- What type and extent of resource degradation is occurring?
- What are the changing trends of exotic species (frequency, abundance, and distribution)?
- What factors contribute to the expansion of exotic and invasive species?
- What effects do exotics and invasives have on Park resources?
- What are the changing trends in rare species (frequency, abundance, and distribution)?
- What are the changes in species [diversity] composition of major habitats?
- What are the changes in spatial distribution and abundance of major vegetation communities (mapping) i.e., communities of concern?
- What are the changing trends in featured species?
- Adjacent land use - rate of change?
- What are the effects of groundwater extraction on water tables (very significant), uplands, estuaries, wetlands and surface water availability?
- How does coastal sand mining effect hydrography (residence time, wave climate, loss of shoals, sediment budget)?What is the frequency and intensity of sand dredging?
- What are the effects of commercial and recreational shellfish harvesting on park aquatic habitats?

Background on Park Specific Monitoring Programs and Needs

Assateague Island National Seashore (ASIS)

Assateague Island encompasses approximately 48,000 acres, half of which is compromised of oceanic and estuarine waters surrounding the island. The park hosted more than 1.8 million visitors in 1999 alone. Changing landuse patterns in surrounding watersheds have threatened the park's estuarine water quality and biotic systems. Disruption of the natural sediment supply to Assateague Island due to the federal navigation channel at Ocean City, MD has been an ongoing management concern as well. Portions of ASIS provide suitable habitat for a variety of state and federally listed species, both plants and animals. The known and perceived threats to these species vary in intensity, and include a range of causative factors including recreational activities, disruptions to natural coastal processes, and interactions with both native and non-native species.

Species and habitats at risk:

- Submerged vascular plant species at risk from deteriorating estuarine water quality.
- Early successional, disturbance-driven beach habitat, and associated plant/animal species at risk from altered coastal processes and recreational activities.
- Rare/sensitive habitats at risk from exotic species.
- Species or communities at risk from recreational activities including off-road vehicle use.

Management Issues:

- Threats to estuarine water quality from adjacent land use practices and development.
- Impacts to coastal processes from adjacent navigation projects (Ocean City, MD Inlet).
- Protection and management of rare, threatened and endangered species.
- Impacts to island habitats from non-native species (deer, horses, or invasive species)
- Threats from recreational and commercial activities within park boundaries.

Existing Monitoring Programs at ASIS:

Estuarine Water Quality	1987
Submerged Aquatic Vegetation	1984
Bathing Beach Water Quality	1990
Estuarine tide/water level	1998
Meteorology	1988
Island Geomorphology	1995
Piping Plovers	1986
Marine Species Strandings	1988
Feral Horses pop. dynamics	1990
Feral Horse Grazing Effects	1991
Mosquitoes/EEE/WNV	1991
North End Vegetation	1996
Seabeach Amaranth	1998
Vegetation Communities	1993

Cape Cod National Seashore (CACO)

The Cape Cod National Seashore was selected as a prototype monitoring park for the Gulf Coast biogeographic region by the National Park Service. The USGS-Biological Resources Division, in cooperation with the NPS, is in the process of designing and testing monitoring protocols for implementation at CACO. Many of the protocols are expected to be directly applicable to other parks within the Coastal and Barrier Network (Appendix D). Cape Cod National Seashore is the prototype monitoring park for the Atlantic and Gulf Coast biogeographic region. The monitoring program is based on the best understanding of processes and component interactions governing the coastal ecosystem, and focuses on addressing management issues that confront coastal parks. An ecosystem-based, issues-oriented program is being developed to detect ecosystem changes, examine contributing factors and consequences of ecosystem changes, and to inform park management of the salient issues that such ecosystem changes represent. The goal of the program is to (1) detect changes in particular attributes of the coastal ecosystem and determine if those changes are within the bounds of natural or historic variability; (2) predict how those changes relate to natural processes and human influences; and (3) understand how such changes, ultimately, affect the condition of the coastal ecosystem. Monitoring data will provide a scientific basis for management decisions leading to effective

protection and restoration of coastal ecosystems. Protocols are being developed to monitor estuarine nutrient enrichment, estuarine nekton (fish and decapod crustaceans), sediment and benthic fauna contaminants, shoreline change, water quality, groundwater hydrology, freshwater fish, aquatic invertebrates, amphibians, waterbirds, landbirds, white-tailed deer, and red foxes and coyotes.

Gateway National Recreation Area

Gateway National Recreation Area is comprised of approximately 26,645 acres of coastal uplands, freshwater ponds, marshes, bays and mudflats. Established in 1972, it is divided into three geographically separate units that constitute some of the largest and most significant natural areas remaining in the metropolitan New York City area. They include Sandy Hook Unit, the Staten Island Unit (Great Kills Park and Miller Field) and the Jamaica Bay/Breezy Point Unit (Riis Park, Fort Tilden, Breezy Point Tip, Floyd Bennett Field, Plumb Beach, north shore of Jamaica Bay and the Jamaica Bay Wildlife Refuge). A tremendous amount of biological information has been produced at GATE through the efforts of park staff and cooperators.

Most Critical Issues for Natural Resources at GATE

* Potential of Port Authority of NY?NJ "forcing" NPS to eliminate Laughing Gull Colony in Jamaica Bay
* Predation Pressures on overall Piping Plover population levels
* Damages to Natural Resources of the Jamaica Bay Wildlife Refuge from landfill leachates
* Loss of 227 acres of buffering properties for Jamaica Bay Wildlife Refuge to housing development
* Major dredging request by Army Corps of Engineers/NYC DEP to "re-profile" Jamaica bay bottom to "eutrophication" concerns from sewage treatment plant (water quality issue)
* Impacts of increased visitor use on marsh and coastal systems
* Illegal shellfishing in Jamaica Bay
* Contaminated dredge material disposal, NYCDEP wants to place on landfills or in park
* Beach erosion at Sandy Hook
* Shoreline housing development Staten Island Great Kills

Management Issues:

* Adjacent lands (Airport and Gulls)
* Piping Plover
* Landfill leaching
* Adjacent landuse encroachment (urban)
* Water quality
* Dredging in bay
* Eutrophication
* Visitor use impacts
* Illegal shellfishing
* Dredge material disposal conflict
* Beach erosion

Existing Monitoring Programs:

* Total/Fecal Coliform (30 sites, includes all contact recreation beaches)

* Temperature, Conductivity, Salinity, Chlorophyll A, Dissolved Oxygen, Light Penetrability (Secchi Disc) 30 sites
* Beach Seining, 30 sites
* Meterological Data (FIREPRO) Floyd Bennett Field
* Herbarium Reference System, Parkwide Vegetation monitoring Rare Plants
* Research Erosion, Parkwide
* Piping Plover "endangered species" Tern
* Tiger Beetle introductions activity, Sandy Hook Unit
* Vegetation SAV's terrestrial
* Peregrine Falcon
* Beaver
* Avian production
* Macro Inverts and Benthic
* Shoreline change
* T&E Species (excluding plover)

Lab required monitoring:
* Sediment contamination levels (Dredging impacts)
* Bioaccumulation/Bioconcentration (Landfill leachates & Estuarine species) Xenobiotics monitoring in finfish/shellfish
* Accretion/Depletion (Shoreline) GIS lab
* Sediment impacts on Native Estuarine Species-Physiology

Other Monitoring Programs going on in the park
* Mussel watch (NOAA)
* HEP (EPA)
* SPDES Permits
* External threats (Vandalia Dunes Development Project, Doppler Radar, etc…)
* Subaqueous borrow pit dredge disposal

Cooperative Support Activities
Wildlife Conservation Society
* Dr. John Behler-Reptile/Amphibian Reintroduction/Captive breeding
* Dr. Dennis Thoney, Dr. Paul Boyl, and Dr. Raul Loizelle-NY Aquarium for Wildlife Conservation: Water Quality Local Waters Initiative
* Landfill Contaminants (DR. Borowsky, Franz, Scriebman, Quinn, Roy and Maillecheruvu)

Polytechnic University
* Dr. D. Roy-Water quality modeling limnological characterization, Jamaica Bay

University of RI (GSO)
* Dr Jim Quinn-Jamaica Bay Contaminants

Brooklyn College
* Dr. David Franz-Bivalves, estuary
* Dr. Martin Schreibman-Winter flounder

The College of Staten Island, CUNY
* Dr. Dick Viet-Neotropical, Breezy Point

Osborn Laboratories of Marine Science

* Dr. Betty Borowsky and Dr. Ander-Physiological stress on food web dynamics from estuarine landfill contaminants.

Fire Island National Seashore (FIIS)

Fire Island National Seashore encompasses approximately 19,580 acres, 11,000 of which are submerged in the Great South Bay or Atlantic Ocean. All existing habitats within FIIS are listed as threatened, and there are eleven species of concern found within the park habitats as well.

Unique resources include:

* Sunken Forest (Maritime Holly Forest)
* Federal Wilderness Area (1300 Acres)
* Eel grass beds
* Approx. 10 Federal or NYS endangered species breed or germinate in park.

Critical management issues include:

* Endangered species breeding and germination
* Adjacent land and water uses
* Coastal erosion
* Exotic species management
* Cultural landscape management
* Recreational use
* Resource harvest
* Deer population management
* Beach re-nourishment
* In-holding issues
* Mosquito management
* Management of commercial interests

Species/Resources Extracted:

* Shellfish harvest (commercial and recreational; subsistence?)
* Crab (recreational, possibly. Commercial)
* Game fishing (Blue Fish, Stripped Bass)
* Waterfowl hunting
* Groundfishing (commercial)
* Groundwater extraction (wells)
* Sand removal (dredging of channels/inlets)
* Deer poaching

Fully Operational Monitoring Programs:

* Major T/E and their habitats
* (Partial) Estuarine Water Quality
* Bayside Erosion
* Beach Invertebrates

Monitoring Needs

* Freshwater wetland monitoring
* Forest/Beach/Dune vegetation monitoring
* Beach inverts.

* Exotics
* ORV's
* Esturay/Bay water quality, SAV's, saltmarsh
* Fox

Colonial National Monument (COLO)

Colonial National Historical Park's 9327 acres are within the coastal plain of Tidewater Virginia. The entire park has a direct hydrological link to the Chesapeake Bay. Most of the park extends along either the York or James Rivers, two of the largest rivers contiguous to the western shore of the Chesapeake Bay. In addition, numerous streams, creeks and ponds flow through the park and feed directly into one of these two rivers. More than 30 miles of shoreline along the James and York rivers bounds the park. In addition, approximately 24 miles of perennial streams and 30 miles of intermittent streams and drainage's flow through the park. Numerous freshwater tributaries in Yorktown flow through the park. As they approach the James and York rivers, these tributaries become tidally influenced estuarine waters.

Issues:

* Changing landuse within drainage basins upstream and outside of park boundaries affecting water quality within the park.
* Floodplains (Approximately 3061 acres of the park are located within the 100-year floodplain).
* Erosion and Sedimentation due to recreational use along river shorelines in the park.
* Shoreline recession threatens the cultural resources of Jamestown Island, Glasshouse Point and Yorktown.
* Groundwater contamination
* Habitats typical of the mid-Atlantic Coastal Plain
* T&E Species (Colonial NHP has the second highest number of rare threatened and endangered species of all the National Park Service units in the state).

Current Monitoring Programs:

* Gypsy moth
* Southern Pine Bark Beetle
* E.coli for public drinking waters
* Eagles
* Breeding bird survey

Other Studies:

* The Division of Natural Heritage has recently completed a detailed management plan for T&E species and habitats within the park.

* The park in cooperation with the Virginia Institute of Marine Science and the US Army Corp of Engineers has conducted a study of the 17 miles of park shoreline along the James River. The study has provided a better knowledge of the shoreline erosion process over the past decades, those areas experiencing the highest erosion rates and recommendations (with alternatives) for conserving the shoreline and its associated cultural and natural resources. A cost benefit analysis has been completed and approved. Major funding has been procured and an EIS is being prepared.

George Washington's Birthplace National Monument

Issues:

* Estuarine species
* Restoration of Pope's Creek estuary as a spawning area for important species like oysters and sturgeon.
* Saltwater and freshwater marsh health
* Riparian habitats
* Forest, marsh and field restoration
* Bank and cliff erosion along the Potomac river
* Exotic species
* Dune habitat management
* T&E species
* Park resource change due to deer
* Pollutants from local industry, municipalities and farming practices
* Re-establishment of native grassland species
* Bald Eagle nesting habitat
* Species extracted from the park (Fish, crabs, deer, waterfowl)

Current Monitoring Programs:
None in existence

Sagamore Hill National Historic Site
Management Issues:
Water quality
Exotic and invasive plant species
In need of baseline inventory work
Current Monitoring Programs:
Level I water quality inventory underway

Thomas Stone National Historic Site
Management Issues:
Riparian ecosystem health
Forest ecosystem health and restoration
Native grassland restoration
Determining the presence of exotic and T&E species
Effects of hunting
Powerline use and species management
Species extracted from park (Deer, fish)
Current Monitoring Programs
None in existence

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National Park Service Inventory and Monitoring Program

A Summary of the Coastal and Barrier Network Monitoring Workshop

April 13th and 14th, 2000

APPENDIX A

Table 1. NPS I&M Program Coastal and Barrier Network Steering Committee Members

Committee Member	Affiliation/Location
Dr. P. A. Buckley	USGS-University of Rhode Island
Dr. Howard Ginsberg	USGS-University of Rhode Island
Dr. Hilary Neckles	USGS-Augusta, ME
Dr. Glenn Gutenspergen	USGS
Dr. Charles Roman	USGS-University of Rhode Island
Dr. Allan O'Connell	USGS-University of Maine
Elizabeth Johnson	NPS-University of Rhode Island
Carl Zimmerman	NPS-ASIS
Dr. Mary Foley	NPS-BOSO
Dr. John Karish	NPS-Penn State University
Dr. John Tanacredi	NPS-GATE
Charles Rafkind	NPS-COLO
Dr. Nancy Finley	NPS-CACO
Jim Ebert	NPS-FIIS

Table 2. NPS I&M Program Coastal and Barrier Network Scoping Workshop Participants

Dr. Jim Allen USGS-PWRC Boston, MA 617-223-5058 James_Allen@usgs.gov	Hilary Neckles USGS-PWRC Augusta, ME 207-622-8205 x119 hilary_neckles@usgs.go	Chuck Rafkind NPS-COLO
Don Stauble USACE- WES 601-634-2056 d.stauble@cerc.wes.army.mil	John Portnoy NPS/CACO 508-847-3262 x107 john_portnoy@nps.gov	Dr. David Franz Biology Department Brooklyn College, 2900 Bedford Ave, Brooklyn, NY 11210 dfranz@brooklyn.cuny.edu
Dr. N. P. Psuty Inst. of Marine and Coastal Science, 71 Dudley Road Rutgers University New Brunswick, NJ 732-932-6555 x500/506 fax 8578 psuty@imcs.rutgers.edu	Loyal Mehrhoff NPS-Endangered Species 1201 Oak Ridge Drive Fort Collins, CO 80525 970-225-3521	Brian Sturgis NPS, Assateague Is NS Brian_sturgis@nps.gov
Scott Hardaway Dept of Physical Science, Virginia Institute of Marine Science, Gloucester Point, VA 23062 804.684.7277 hardaway@vims.edu	Kirk Havens VIMS PO Box 1346 Gloucester Point VA 23062 804-684-7386 fax 7179 kirk@vins.edu	Dr. John Tanacredi NPS_GATE 718-354-4520 john_tanacredi@nps.gov
Ellen Gray NPS NCR	Dave Avrin, NPS-GATE	Tonnie Maniero NPS-WASO AIR
Carl Zimmerman NPS-Assateague Island NS Carl_zimmerman@nps.gov	Gary Rosenlieb, Water Resource Division Gary_rosenlieb@nps.gov	Joel Wagner NPS-WASO WRD Joel_wagner@nps.gov
Mike Shaver NPS-SAHI	Jim Ebert NPS-FIIS	Rijk Morawe NPS-GEWA/THST

Table 2. Cont.

Elizabeth Johnson Northeast Region I&M Coord. 237 Woodward Hall, URI Kingston, RI 02881 401-874-7060 beth_johnson@nps.gov	Dr. Steven Fancy NPS WASO I&M 1201 Oak Ridge Drive Fort Collins, CO 80525 Steve_fancy@nps.gov	Dr. Jeff Marion, USGS-PWRC VATech Cpsu@vt.edu
Bill Jackson NPS- WASO WRD bill_jackson@nps.gov	Wayne Millington NPS, IPM Coordinator 814-863-8352 Wayne_Millington@nps.gov	Dr. Charles Roman USGS-PWRC Croman@gso.uri.edu
Dr. Alan O'Connell USGS-PWRC Orono, ME 207-581-2873 oconnell@umit.maine.edu	Mark Duffy NPS Assateague (GIS) Mark_duffy@nps.gov	Dr. Frank Panek USFWS, 300 Westgate Center Dr. Hadley,MA 01035-9689 413-253-8495
Bob Higgins NPS-Geologic Division Bob_Higgins@nps.gov	Norman Rubinstein EPA, Atlantic Ecology Divison 27 Tarzwell Dr. Narragansett, RI 02882 401-783-3001 normr@etal.uri.edu	Kathy Konicki USGS 384 Woods Hole Road, Woods Hole, MA 02543 508-457-2351 kkonicki@usgs.gov
Bob Cook NPS-CACO	Scott Gurney NPS-SAHI	Mark Ringinary NPS-GATE
Ernie Taylor NPS-FIIS Ernest_taylor@nps.gov 603-289-1711	Janet Keough USGS Patuxent Janet_keough@usgs.gov 301-497-5754	Gary Brewer
Kristen Gounaris NPS-COLO	Chris Lea NPS-ASIS	

Table 3. People who were invited to the workshop, but were unable to attend. (Some may review the monitoring report)

Bob Shedlock USGS-MD Baltimore, MD Rjshedlo@usgs.gov	Randolf McBride George Mason University rmcbride@osf1.gmu.edu 703-993-1642	Mike Facazio 703-648-6808 mike_facazio@usgs.gov
Robert Cerrato SUNY Stony Brook Stony Brook, NY 11794 rcerrato@notes.cc.sunysb.edu	Chuck Nieder Hudson River NERRS C/o Bard College Field Station Annandale, NY 12504 cnieder@ocean.nos.noaa.gov 914-758-7033	Mr. Ward Staubitz USGS, District Chief, Virginia, Water Resources, Richmond, VA staubitz@usgs.gov (804) 261-2600
Jeff Williams USGS Coastal and Marine Geology Program 915-B National Center, Reston, VA 20192 jwilliams@usgs.gov (703) 648-6511	William Reay Research director NERRS, Chesapeake Bay National Estuarine Research Reserve in VA, VIMS, Glouster Point, VA 23062 Wreay@vims.edu 804-684-7119	Dr. Joan Ehrenfeld DEENR,14 College Farm Rd., Cook College, Rutgers University, New Brunswick, NJ 08903 732-932-1081 ehrenfel@rci.rutgers.edu
Dr. Peter Paton University of Rhode Island Ppaton@uri.edu	Dr. Howard Ginsberg USGS-PWRC hgi0011u@uri.edu	Paul Barlow USGS-MA Pbarlow@usgs.gov
Scott Melvin Division of Fish and Wildlife, Natural Heritage Program, Westborough, MA 01581 scott.melvin@state.ma.us 508-792-7270 ext 150	Dr. Jeff List USGS 384 Woods Hole Road, Woods Hole, MA 02543 Jlist@usgs.gov 508-457-2343	Dr. William Patterson Department of Forestry and Wildlife, UMass, Amherst, MA 01003 wap@forwild.umass.edu 413-545-2757
Dr. Martha Mather USGS, Coop Research Unit, UMass Amherst, MA Mather@forwild.umass.edu	Bob Orth VIMS 804-684-7392 jjorth@vims.edu	Jeff Levinton SUNY Stony Brook Stony Brook, NY 11794 levinton@life.bio.sunysb.edu
Mr. Chris Ludwig, Manager, Monitoring Branch Va. Dept of Conservation and Recreation, Division of Natural Heritage, Richmond, VA jcl@dcr.state.va.us 804.371.6206	Michael Erwin USGS Patuxent Wildlife Research Center Dept of Environmental Sciences Univ. Virginia Charlottesville, VA rme5g@virginia.edu	David Manski/Charlie Jacobi NPS_ACAD David_manski@nps.gov
George Frame NPS-GATE	Dr. Bob Manning University of VT	Dr. Glenn Gutenspergen USGS
Christine Kurtzke NPS-GATE	Dr. Brian Underwood USGS_PWRC hbunderw@mailbox.syr.edu	Dr. Martin Schreibman 718-951-5631 Martins@brooklyn.cuny.edu
Dr. Mary Foley NPS-BOSO Mary_foley@nps.gov	Nigel Shaw NPS BOSO (GIS) Nigel_Shaw@nps.gov	Dr. P. A. Buckley USGS_PWRC URI pabuckley@gsosun1.gso.uri.edu
Bob Orthno VIMS 804-684-7392 jjorth@vims.edu	Dr. Howard Ginsberg USGS University of Rhode Island	

Table 4. NPS I&M Program Coastal and Barrier Network Workgroup Assignments

Shoreline Change
James Allen, Leader
Don Stauble
Scott Hardaway
Kathy Konicki
Jill Bodnar
Mark Duffy
Bob Higgins
Norm Psuty
Jeff List (unable to attend)
Jeff Williams (unable to attend)
Nigel Shaw (unable to attend)

Species and Habitats of Concern
Allan O'Connell, Leader
Chris Lea
Kristin Gounaris
Bob Cook
Loyal Mehrhoff
Sandy Brue
Steve Fancy
Janet Keough
Joel Wagner
Wayne Millington
Ellen Gray
Frank Panek
Mike Shaver
Ernie Taylor
George Frame (unable to attend)
P.A. Buckley (unable to attend)
Joan Ehrenfeld (unable to attend)
Howard Ginsberg (unable to attend)
Martha Mather (unable to attend)
William Patterson (unable to attend)
Brian Underwood (unable to attend)
Peter Paton (unable to attend)

Water Quality
Hilary Neckles, Leader
Gary Rosenlieb, Leader
John Portnoy
Brian Sturgis
Kirk Havens
Norman Rubenstein
Charles Rafkind
Rijk Morawe
Mark Ringinary
Scott Gurney
William Reay (unable to attend)
Ward Staubitz (unable to attend)
Chuck Nieder (unable to attend)
Kent Mountford (unable to attend)
Bob Shedlock (unable to attend)

Resource Extraction
Dave Avrin, Leader
David Franz
John Tanacredi
James Ebert
Gary Brewer
Bill Jackson
Carl Zimmerman
Tonnie Maniero
Bob Orth (unable to attend)
Paul Barlow (unable to attend)
Christine Kurtzke (unable to attend)

Recreation and Visitor Use
Jeff Marion, Leader
Charles Roman
Bruce Lane
Elizabeth Johnson
David Manski (unable to attend)
Charlie Jacobi (unable to attend)
Bob Manning (unable to attend)
Michael Erwin (unable to attend)
Mary Foley (unable to attend)

APPENDIX B

Briefing Materials for the Coastal and Barrier Network Monitoring Workshop

Document I	**Scoping Workshop Agenda and Format**
Document II	**Significant Resource Issues for North Atlantic Coastal Parks**
Document III	**A summary of a workshop held by the Patuxent Wildlife Research Center on coastal issues.**
Document IV	**Coastal and Barrier Network Resource and Settings**

Document I

Scoping Workshop Agenda and Format

VITAL SIGNS WORKSHOP AGENDA

National Park Service
Northeast Region: Coastal and Barrier Network
Gateway National Recreation Area
April 13 and 14, 2000

Wednesday April 12: Lodging at Ft. Wadsworth Navy Lodge

Thursday April 13: Fort Wadsworth, Building (tba)

7:00-7:45 AM	Breakfast provided	
8:00-8:15 AM	Welcome, Logistics	John Tanacredi Gateway National Recreation Area
8:15-8:45 AM	Vital Signs	Elizabeth Johnson NPS, Northeast Region I&M Coordinator
8:45-9:15	The Cape Cod Prototype: A Framework for Monitoring	Charles Roman USGS, Patuxent
9:15-9:30 AM	Instructions to Workgroups	Elizabeth Johnson
9:30-9:45	BREAK	
9:45-11:00	Go to Assigned Workgroups: Identify Monitoring Questions	
	Shoreline Change: James Allen, Leader	
	Water Quality: Hilary Neckles and Gary Rosenleib, Leaders	
	Species and Habitats of Concern: Allen O'Connell, Leader	
	Recreation Visitor Use: Jeffrey Marion, Leader	
	Resource Extraction: Dave Avrin, Leader	
11:00-12:00	Workgroups Present Summary of Monitoring Questions	Workgroup Representative
12:00-1:00	Hot Lunch Provided	
1:00-1:15	Integrating Components/Data Management Demonstration of GIS Data Browser	Steven Fancy NPS-Monitoring Specialist

1:15-1:30	Complete Presentation of Monitoring Questions Instructions to Workgroups	Elizabeth Johnson
1:30-4:30	Return to Workgroup Discussions Identify linkages to other groups Identify vital signs Complete Vital Signs Templates	
3:30	BREAK	
4:30-6:00	Workgroups Present Preliminary Summary of Vital Signs Discussion of Preliminary Summary	
6:30	Dinner in New York City transportation and location provided	John Tanacredi

Friday, April 14

8:00-8:15AM	Good Morning, Workgroup Instructions	Elizabeth Johnson
8:15-10:00 AM	Continue Workgroup Tasks Complete Templates Priority Setting	
10:00	Break	
10:30-12:00	Workgroup Presentations and Discussion of Vital Signs	
12:00-1:00	Where do we go from here? Complete Individual Participant Template Recommend reviewers	Elizabeth Johnson
1:00-1:30	Lunch provided “to go” if necessary	
1:30	End	

During the workshop, messages may be faxed to 718-354-4548 and will be posted at the workshop

See Jill Bodnar, URI for a demonstration of the NPSpecies database for your park

See Steve Fancy, Monitoring Specialist for I&M Program for demonstration of the GIS data browser

IDENTIFYING "VITAL SIGNS" FOR NORTHEAST COASTAL PARKS: A WORKSHOP

INTRODUCTION

In 1999, the National Park Service announced a 5 year action plan, the "Natural Resource Challenge", for preserving natural resources in parks. One of the core activities endorsed in the Challenge was to "monitor vital signs in all parks from 32 biome-based networks of parks" with a cost of $38.4 million phased in over the next 5 years. The Challenge allocates $26.5 million for monitoring biological resources, $5.9 million for air quality monitoring and $6.0 million for water quality monitoring and assessment. Parks within a network must work together to identify the highest priority, most appropriate vital signs. Key vital signs can then be monitored to track the condition of the park ecosystem over time.

One of these biogeographic networks is the Coastal and Barrier Network that includes 8 Atlantic Coast and Chesapeake Bay parks from Massachusetts to Virginia. This network should receive funding in October 2000 to initiate its vital signs monitoring program. Developing a monitoring program for the Coastal and Barrier Network involves identifying management issues and ecosystem types represented in the Network, reviewing existing information, seeking input and advice from experts from inside and outside the National Park Service to identify monitoring needs and priorities, identifying partners and developing a plan of action.

WORKSHOP PURPOSE

This workshop is a first step in planning a vital signs monitoring program to address the most critical natural resource management issues in the National Park Service Coastal and Barrier Network. The purposes of this workshop are to:

- Generate monitoring questions that address management issues in coastal parks,
- Identify and prioritize indicators for long term monitoring that provide quantitative information on coastal ecosystem functions such as response to stressors, and
- Catalog existing monitoring programs and protocols for identified indicators, (location, duration, parameters), and identify gaps in existing programs

The Coastal and Barrier Network includes 8 parks: Assateague Island National Seashore in Maryland (ASIS), Cape Cod National Seashore in Massachusetts (CACO), Colonial National Historical Park in Virginia (COLO), Fire Island National Seashore on the south shore of Long Island (FIIS), Gateway National Recreation Area in New York and New Jersey (GATE), George Washington's Birthplace National Monument in Virginia (GEWA), Sagamore Hill National Historic Site on the north shore of Long Island (SAHI) and Thomas Stone National Historic Site in Virginia (THST). Information on the natural resources and management issues within individual parks will be sent prior to the workshop for participants to review. These 8 parks will work together to develop a long-term vital signs monitoring program that addresses the most important issues for the network as a whole.

BACKGROUND

What are Vital Signs?

Vital signs are key elements, processes or features of the environment that can be measured or estimated AND that indicate the condition of an ecosystem.

Another way to word this is: "Vital signs are environmental indicators; they are measurable characteristics of the environment that are related to the condition of an ecosystem in a way that can be quantified and interpreted."

What are the Objectives of Vital Signs Monitoring?

The objectives of a vital signs monitoring program are aimed at detecting, understanding and predicting change in the condition of an ecosystem. It is an anticipatory, early warning system that signals degradation before serious harm has occurred.

A successful program should

- Detect change in the status of particular physical, chemical or biological attributes or vital signs of the ecosystem (e.g. species abundance, reproductive success or dissolved oxygen, soil compaction or nutrient cycling)
- Determine if changes are within the bounds of natural variability
- Indicate the natural and human-induced factors affecting the observed changes,
- Provide insights into the ecological consequences of changes,
- Anticipate ecosystem impacts enabling proactive management actions, and
- Evaluate the success of management actions.

WORKSHOP PRODUCTS

The objectives of the workshop are to develop a vital sign monitoring program for the Coastal and Barriers Network, consisting of:

- A list of significant **management issues** influencing the ecosystem,
- A list of issue related **monitoring questions** which a monitoring program could be designed to answer.
- A list of **vital signs** that address the identified monitoring questions.
- **Prioritization of vital signs.**

The resulting Vital Sign Monitoring Program will consist of a prioritized set of monitoring variables that are relevant to the management issues and natural resources of National Park Service Coastal and Barrier Parks. Some variables will be applicable to all parks in the network, whereas others may relate to only one or several parks. The ecosystems and management issues to which they apply will classify variables.

WORKSHOP PROCESS

In 1998, the National Park Service began to identify vital signs in individual parks through facilitated workshops with the idea that vital signs from parks would eventually roll up to be evaluated and prioritized on a network basis. Parks in the Northeast have not been through this process. However, the National Park Service and the USGS-Biological Resources Division have developed a long-term "prototype" monitoring program at Cape Cod National Seashore that is ecosystem-based and issue-oriented. It is expected that many of the protocols will have direct application at other seashore parks in the region and the development team has been working closely with other parks, universities, other government agencies and conservation organizations. Pre-workshop materials have been drawn from a synthesis of this work in "Conceptual Framework for the Development of Long-term Monitoring Protocols at Cape Cod National Seashore".

A steering group was formed to develop pre-workshop materials in order to set the stage for identifying and prioritizing vital signs for the Coastal and Barrier Network. The steering group selected management issues and representative ecosystems for the network, proposed monitoring questions and identified related vital signs. All materials are to be used as a take off point in group discussions.

The following Network ecosystems were selected based on the Cape Cod model that are generally representative of all coastal park units (i.e. we could divide units up any number of ways, with more or less lumping/splitting of habitats, but these are the major systems):

- Estuaries and near shore environments
- Freshwater wetlands, ponds and streams
- Uplands: Forests, grasslands and thickets
- Beaches, dunes, spits and shoreline systems

Management issues were selected based on past input from the Parks (see coastal parks issues presented at PWRC Coastal Symposium-1999). The steering group proposed monitoring questions and candidate vital signs within each Management Issue based largely on the Cape Cod National Seashore prototype. Candidate vital signs are broadly applicable and assumed to be relevant to most Coastal and Barrier Network Units.

Workshop participants were selected based on knowledge of park resources and issues in the Coastal and Barrier Network and/or scientific expertise relevant to selected ecosystems. Participants will be divided into Work Groups aligned with the following management issues:

- Shoreline Change
- Water Quality
- Species and Habitats of Concern
- Resource Extraction
- Recreation and Visitor Use

Work groups are asked to examine all of the pre-workshop materials for relevance and completeness. Are the vital signs complete? Are there other variables that are more appropriate for application to most network NPS Units? Should additional variables be included that may relate to only a small number of units?

What are Characteristics of the Ideal Indicator or "Vital Sign"?

It has been said that:

"Everything is an indicator or something and nothing is an indicator of everything".

The vital signs process looks for early warning indicators, not diagnostic or retrospective indicators. Therefore, the following "Characteristics of an Ideal Indicator" should be considered in the selection of vital signs.

Consider environmental features or indicators that:

- have dynamics that parallel those of the ecosystem or component of interest;
- are anticipatory: they signal degradation before serious harm has occurred;
- are sensitive enough (or broadly applicable to many stressors) to provide an early warning of change;
- have a high "signal to noise", are relatively insensitive to factors other than the stressor;
- provide a continuous assessment over a wide range of impacts;
- have dynamics that are easily attributed to either natural cycles OR anthropogenic sources;
- are distributed over a wide geographical area and/or are very numerous;
- can be accurately and precisely estimated;
- have low natural variability;
- have known variability and other statistical properties so criteria for being "out of range" are known;
- are at an appropriate scale;

- are constant during the period of measurement;
- are easy to measure, time and cost effective and standard protocols are available;
- are related to ecosystem condition in a way that can be interpreted and explained, there is a clear connection between the indicator and the function it reflects;
- are low impact or non-destructive to measure and;
- have measurable results that are repeatable/consistent with different observers;
- are timely and provide information quickly enough to react;
- are unique and do not duplicate other indicators;
- can be communicated to managers and the public;
- are socially relevant and politically appealing: people care about the indicator.

Work groups will begin by evaluating the monitoring questions presented in the draft Vital Signs Monitoring Program (attached). Monitoring questions will be presented by each workgroup to all participants early on in the session. After that, workgroups will continue to identify and describe vital signs on the templates provided (attached). Each workgroup will prepare a series of "Vital Signs Templates" to describe monitoring questions and vital signs. Each workgroup will eventually summarize their work on the "Workgroup Summary Sheet". Each participant will make individual recommendations on the most important management issues, monitoring questions and indicators for the record on the "Participant Summary Sheet".

Following the workshop, workgroup leaders and the steering group will prepare a report that discusses the dynamics of the network ecosystems and the rationale for identifying vital signs, and lists the monitoring questions, vital signs selected and the priorities for long-term monitoring. This document will undergo extensive review by parks, recommended peers and workshop participants prior to being submitted as a plan for the network.

ADDITIONAL MATERIAL TO BE PROVIDED AT THE WORKSHOP

- Park brochures
- NPSpecies: A database of probable and verified vertebrate and vascular plant species in the network
- A preliminary list of available spatial data and other non-spatial databases
- NRBIB: A Bibliography of Natural Resources reports, maps, photos, information
- A set of base maps for each park in the Network
- Final Agenda
- A summary of Coastal Issues Symposium PWRC
- "*Conceptual Framework for the Development of Long-term Monitoring Protocols at Cape Cod National Seashore*"
- Work group ground rules
- Workshop participant list

VITAL SIGNS MONITORING PROGRAM

MANAGEMENT ISSUE: SHORELINE CHANGE

Applicable Ecosystems: beaches/dunes/spits/shoreline; estuaries and near shore environments
Monitoring Question: What is the rate of shoreline change throughout the park?

VITAL SIGN: Location of mean high water, shoreline position
VITAL SIGN: Near shore topography
VITAL SIGN: Beach and back bay morphology
VITAL SIGN: Position and frequency of over washes or breeches
VITAL SIGN: Bluff retreat

Monitoring Question: What factors contribute to shoreline change? (Natural or anthropogenic?)

VITAL SIGN: wave energy measures
VITAL SIGN: near shore topography (dune integrity)
VITAL SIGN: sea level
VITAL SIGN: marsh bank erosion, accretion
VITAL SIGN: other measurable storm effects

MANAGEMENT ISSUE: CHANGE IN WATER QUALITY

Applicable Ecosystems: wetlands/ponds/streams; estuaries and near shore environments

Monitoring Question: Is water quality changing in freshwater, estuarine and/or marine environments?

VITAL SIGN: aerial extent, community composition and community structure of aquatic habitats (e.g. mudflats, seagrass beds, salt marsh, freshwater wetland, vernal pools, streams, ponds)
VITAL SIGN: nutrient and contaminants input
VITAL SIGN: concentration of chemical and physical constituents in the water column, sediments, and plant tissue

Monitoring Question: What is the effect of a change in water quality on park resources?

VITAL SIGNS: same as above
VITAL SIGN: aquatic species populations, growth, reproduction, other

Monitoring Question: What factors contribute to change in water quality?

VITAL SIGN: land use change (population density, development, water use, sewage)

MANAGEMENT ISSUE: SPECIES AND HABITATS OF CONCERN
Applicable Ecosystem: Estuaries and Near Shore Environments
Applicable Ecosystem: Freshwater Wetlands, ponds, streams
Applicable Ecosystem: Uplands: forest, grasslands, thickets
Applicable Ecosystem: Beaches, dunes, spits, shoreline systems

Workgroups should create a list of species and habitats of concern to the network and refine the lists for individual parks based on information provided by the parks in the Appendix. Establish priorities (measuring the distribution of one species over another) and identify which vital sign tracks which species.

Monitoring Question: Are invasive species spreading?

VITAL SIGN: distribution of invasive species
VITAL SIGN: numbers of individuals of invasive species

Monitoring Question: What effects do invasive species have on park resources?

VITAL SIGN: distribution of other species
VITAL SIGN: reproduction of other species

Monitoring Question: What factors contribute to invasive species expansion?

VITAL SIGN: measurable disturbance regimes (land use patterns, human use patterns, soil disturbance, etc.)
VITAL SIGN: densities and distribution of vectors (pathways of spread for vector borne disease

Monitoring Question: Are distribution and abundance of rare species and habitats changing?

VITAL SIGN: population status, abundance, distribution of rare species
VITAL SIGN: community status

Monitoring Question: What factors contribute to change in distribution and abundance of rare species?

Monitoring Question: How do changes in park coincide with or impact on regional changes?

MANAGEMENT ISSUE: RECREATION VISITOR USE
Applicable Ecosystem: Estuaries and Near Shore Environments
Applicable Ecosystem: Freshwater Wetlands, ponds, streams
Applicable Ecosystem: Uplands: forest, grasslands, thickets
Applicable Ecosystem: Beaches, dunes, spits, shoreline systems

Monitoring Question: Are current patterns of visitor use influencing natural resources?

VITAL SIGN: populations of plant and animal species
VITAL SIGN: rate of soil compaction, erosion
VITAL SIGN: vegetation trampling

Monitoring Question: Are patterns of recreational use changing?
VITAL SIGN: distribution and abundance of humans
VITAL SIGN: type and location of visitor activities

MANAGEMENT ISSUE: RESOURCE EXTRACTION

Applicable Ecosystem: Estuaries and Near Shore Environments
Applicable Ecosystem: Freshwater Wetlands, ponds, streams
Applicable Ecosystem: Uplands: forest, grasslands, thickets
Applicable Ecosystem: Beaches, dunes, spits, shoreline systems

Resource extraction includes shell fishing, fishing, hunting, poaching, groundwater withdrawal, collecting, harvest, other.

Workgroup should refine the list of species/items extracted and habitat affected that is provided by parks AND should identify which resources relate to specific vital signs.

Monitoring Question: Are current magnitude and patterns of resource extraction changing?

VITAL SIGN: density, frequency, location of resource extraction
VITAL SIGN: numbers of resources removed

Monitoring Question: What is the effect on park resources?

VITAL SIGN: species populations
VITAL SIGN: water table level, base flow, discharge (groundwater hydrology)
VITAL SIGN: habitat structure

Work groups will fill out the following template for each vital sign selected.
****

Vital Signs Template

Management Issue:

Monitoring Question Addressed:

Vital Sign:

What ecosystems does this Vital Sign apply to?

Estuaries and Near Shore Environments ___

Freshwater Wetlands, ponds, streams ___

Uplands: forest, grasslands, thickets ___

Beaches, dunes, spits, shoreline systems ___

Why was this vital sign chosen?

Other information (monitoring information, protocols, costs, potential partners, related on-going research, suggested inventory needs, reviewers, etc.):

Contact person:

WORKGROUP SUMMARY SHEET
This template should be filled out by workgroups and is intended to capture the discussion that occurs in each workgroup. Each group is nominating their top three + overall vital signs. This will help prepare for the final presentation by each workgroup and will be a required workgroup product.

WORKGROUP_____

What are the network's top three monitoring questions in priority order?

If we can monitor only one or two vital signs for the network, what would they be?

If we can monitor 3 or 4 vital signs, what would they be?

If we can monitor 5 or more vital signs what would they be?

Please set priorities on above: HIGH, MEDIUM, LOW

PARTICIPANT SUMMARY SHEET

After each workgroup presents vital signs to all workshop participants, please respond to the questions below and justify your responses.

Participant Name _____

Q: What are the most important issues that are common to all parks in the network?

Q: What are the network's top three monitoring questions in priority order?

Q: What are the top vital signs?

Q What are other high priority issues significant to one or a few network parks?

Q Other comments: on the vital signs process, recommended names, email, phone of potential reviewers

Document II
Significant Resource Issues
NATIONAL PARK SERVICE
North Atlantic Coastal Parks

The following are brief descriptions of significant natural resource issues faced by National Park Service units in the North Atlantic coastal region. It is by no means a comprehensive accounting, but rather an overview, intended to illustrate the range of problems and issues for which there is a need for improved information, scientific investigation, and technical assistance.

Impacts to Water Quality. North Atlantic coastal parks are fundamentally aquatic parks, dependent upon high quality water resources to sustain the complex biotic systems inherent to the estuarine and nearshore oceanic environments they represent. The quality of these resources are, however, being threatened by dramatic changes in the patterns and intensities of land use and development in the adjacent watersheds. In most cases, eutrophication from unnaturally elevated non-point source inputs of nutrients (including atmospheric) is the primary threat, although in several units contaminants are also of particular concern. Other problems include impacts to freshwater ponds and wetlands associated with groundwater withdrawals, acidification of surface waters from atmospheric deposition, contaminants from dredging activities, and harmful algal blooms. With population growth in the coastal zone projected to continue indefinitely, the potential for continued stress on park water resources is high.

Coastal Erosion. With the exception of Acadia, all of the North Atlantic coastal parks are faced with a wide variety of problems related to coastal erosion. In many cases, these problems are the result of human perturbations of the littoral system occurring either within or adjacent to the parks. For example, impacts to sediment supply from updrift groin fields or jetty stabilized inlets, or the loss of overwash habitat from dune stabilization for storm protection. Other problems derive from the inherent incompatibility of development infrastructure with the dynamic nature of coastal barriers. Even in the context of natural shore change, the status quo of automobile accessed, fixed location recreational amenities is probably not sustainable. Overarching all is the prospect of accelerated rates of coastal change brought on by global climate change and sea level rise.

Non-native and invasive species. Coastal habitats, both terrestrial and aquatic, are threatened by a growing number of non-native and/or invasive species. At Acadia and Assateague for example, more than 30% of the recorded vascular plant species found in these areas are non-native. While most are relatively innocuous, some, such as purple loosestrife, japanese buckthorn, phragmites, and asiatic sand sedge are extremely invasive and have the potential to result in significant ecosystem impacts. Of equal concern is the growing number of non-native aquatic animal species being reported in estuaries up and down the Atlantic coast. In many cases, these species are influencing native park habitats and/or communities that have not yet been fully documented.

Rare, Threatened and Endangered Species. North Atlantic coastal parks provide suitable habitat for a wide variety of state and federally listed species, both plants and animals. The known and perceived threats to these species vary in intensity, and include a range of causative factors including loss of habitat, recreational activities, disruption of natural coastal processes, and interactions with both native and non-native species. Certain high-profile species such as the piping plover are being actively investigated and managed, but others remain poorly understood and are largely ignored. In particular, rare resident plant and insect species and transient bird and marine animal species lack appropriate levels of documentation, assessment, and threat mitigation.

Habitats and Communities of Special Significance. As human activities have progressively altered coastal ecosystems, many of the endemic habitats and biotic communities have become increasingly rare, at spatial scales ranging from local to international. As a consequence, NPS coastal parks are becoming more and more important for their role in preserving remnants of natural habitat and as repositories of biological diversity. For example: the heathlands and kettle ponds of Cape Cod, maritime forests at Fire Island, and overwash flats and seagrass meadows at Assateague. The threats to these

resources are many and varied, and include the suppression of natural fire, native species overpopulation, commercial fisheries, habitat fragmentation, air and water-borne pollutants, recreational activities, altered coastal processes, and exotic species. Some of these resources are also considered to be at high risk from the effects of global climate change. Such effects may be particularly significant in areas where species' range limits converge, as occurs at Acadia and Assateague.

Public Health Protection. Problems associated with the protection of public health in coastal parks have become much more visible over the past decade. Because of the high potential for controversy and misunderstanding, accurate information and appropriate management strategies are critical. Prominent issues include mosquito-borne diseases such as Eastern Equine and the newly-arrived West Nile encephalitis viruses, lyme disease, rabies, bathing beach water quality, and the safety of consumed species (e.g. mercury in fish). In some cases, these issues also have significant ecological implications that warrant improved understanding and consideration. For example, the ramifications of differing mosquito control treatment strategies.

Visitor Use Management. Crowding, traffic congestion, conflicts among user-groups, and the degradation of natural resources are threatening the quality of visitor experiences at parks everywhere. With annual visitation surpassing twenty million, the five North Atlantic coastal parks are meccas for outdoor recreation. However, in some parks visitors report altering their use patterns to avoid crowds, while in others, the physical capacity of existing infrastructure is routinely exceeded. Protecting high quality visitor experiences given the increasing demand for outdoor recreation will be a significant challenge.

Document III

COASTAL ISSUES AND INFORMATION NEEDS

A Summary of the Coastal Issues Symposium held
February 10-11, 1999
as part of the
USGS Patuxent Wildlife Research Center
Annual Science Meeting

EXECUTIVE SUMMARY

The Patuxent Wildlife Research Center hosts an Annual Science Meeting of Center scientists and Federal, State, and local partners in natural resource management. This meeting is designed to encourage a maximum amount of dialogue among Center scientists and science partners for the purpose of identifying respective capabilities and information needs and capturing emerging issues. The meeting results are used to shape scientific programs at the Center that are highly relevant to natural resource management needs and maintain high standards of professional excellence. Several areas of emphasis are selected for in-depth discussions at each meeting. One area so highlighted at the February, 1999, meeting was the coastal zone. During two, half-day sessions, internationally recognized leaders in coastal ecology joined forces with Department of the Interior coastal land and resource managers to identify key scientific issues, information gaps, and long-term data needs that are relevant within a coastal resource management framework. Although the issues that arose are applicable at national and global scales, the primary focus of discussions was the eastern U.S. The issues that were identified are summarized here. We hope that this information will yield productive partnerships among scientists and managers whose interests, expertise, and jurisdiction coincide in Atlantic and Great Lakes coastal habitats.

The need for a coordinated approach to research and management of coastal ecosystems has never been greater. Continued population growth in the coastal zone and concomitant urban, industrial, and agricultural development threaten natural resources with a host of anthropogenic stressors. Scott Nixon (University of Rhode Island) identified the primary anthropogenic sources of inorganic nitrogen to coastal waters, including fossil fuel combustion, fertilizer application, sewage treatment plant discharge, and septic system runoff. With increasing world populations and demographic shifts to coastal population centers, fertilizing inputs of nitrogen to estuaries and coastal embayments are expected to rise. Unchecked, the ultimate response to nutrient over-enrichment will be increased eutrophication of coastal systems. Barnett Rattner (USGS) described how resident and migratory vertebrate wildlife of Atlantic coast estuaries are also at risk from environmental contaminants. David Burdick (University of New Hampshire) discussed the historic and continued physical alterations to coastal habitats. Direct impacts to salt marsh and seagrass habitats arise from sediment fill or removal associated with upland and nearshore development projects, and indirect effects persist from hydrologic alterations. As described by Jim Allen(USGS), natural processes contributing to shoreline change can exacerbate the effects of human alterations to coastal environments.

Effective preservation and restoration of coastal ecosystems requires a collaborative approach for establishing research and management priorities, conducting necessary investigations, and applying new information. Problems in the coastal zone stem from complex processes interacting across a variety of temporal and spatial scales, and they require integrated, interdisciplinary responses. Bruce Hayden (University of Virginia / National Science Foundation) described how place-based, long-term ecological research can help detect trends in processes and causes for responses that occur on generational time scales. Peter Barnes (USGS/GD)and Peter Weiskel (USGS/WRD) described broad ranging, physical science expertise within USGS for addressing shoreline change and land-to-sea fluxes of water and materials. These capabilities complement the traditional ecological expertise at Patuxent, and Suzette Kimball, USGS/BRD Eastern Regional Chief Biologist, pledged collaboration across USGS Divisions to tackle coastal issues. Linkages with partner bureaus are essential to this process. Representatives of the National Park Service and the Fish and Wildlife Service with responsibilities for coastal lands and resources in the eastern U.S. identified many common themes, concerns, and information needs related to coastal ecosystem management.

This report is organized within overarching categories presented at the Coastal Issues Symposium: Physical Alterations of Coastal Habitats; Nutrient Enrichment: Sources and Ecosystem Responses; Shoreline Change

Processes; and Long-term Monitoring and Research. Each issue includes recommendations for future scientific programs, based on information needs presented by partner bureau representatives and discussions among symposium participants. Specific science needs identified by National Park Service and Fish and Wildlife Service representatives are appended with contact information. We hope that this report serves as a springboard for future professional interaction, collaboration, and scientific investigation of coastal ecosystems in the eastern U.S.

Symposium Organizers:
Jim Allen, Janet Keough, Hilary Neckles, Charles Roman
USGS Patuxent Wildlife Research Center

COASTAL ISSUES SYMPOSIUM
February 10-11, 1999
USGS Patuxent Wildlife Research Center
Laurel, Maryland

SYMPOSIUM OBJECTIVES

Coastal Issues

- Identify key research issues, information gaps, and long-term data needs that are relevant within a resource management framework.

DOI Land Management Needs

- Provide an opportunity for client agencies (e.g., FWS, NPS) to identify their priority coastal issues that require research and technical assistance toward the development of resource management planning, policy development and resource protection.

Communication and Partnership

- Provide an opportunity to foster communication among BRD coastal scientists, other USGS Divisions, and client bureaus; focus discussions on research capabilities that reflect the needs of coastal land managers.

Strategies

- Summarize the key issues, client needs, and opportunities for productive partnerships and develop a strategy for developing a comprehensive coastal studies program that is responsive to land managers and maintains professional excellence.

AGENDA
Wednesday, Feb. 10

2 - 2:10pm SYMPOSIUM INTRODUCTION & OBJECTIVES
Charles Roman
USGS Patuxent Wildlife Research Center - Univ of Rhode Island

Keynote Addresses

2:10 - 2:35 PHYSICAL ALTERATIONS OF COASTAL HABITATS
David Burdick
Jackson Estuarine Laboratory, University of New Hampshire

2:35 - 3:00 NUTRIENT ENRICHMENT: SOURCES AND ECOSYSTEM RESPONSES
Scott Nixon
Graduate School of Oceanography, University of Rhode Island

3:00 - 3:20 Break

3:20 - 3:45 SHORELINE CHANGE PROCESSES
James Allen
USGS Patuxent Wildlife Research Center - Boston

3:45 - 4:10 LONG-TERM COASTAL DATA AND LTER PROGRAMS

Bruce Hayden
University of Virginia and National Science Foundation, Div. of Environmental Biology

USGS Coastal Research Capabilities

4:10 - 4:35 USGS COASTAL AND MARINE GEOLOGY PROGRAM
Peter Barnes
USGS Coastal and Marine Geology Program - Reston

4:35 - 5pm USGS WATER RESOURCES DIVISION
Peter Weiskel
USGS Water Resources Division, Massachusetts-Rhode Island District

Thursday, Feb. 11

Issues and Research Needs: DOI Land Managers

8:00a - 8:10 INTRODUCTION TO CLIENT NEEDS AND PERSPECTIVES
Janet Keough
USGS Patuxent Wildlife Research Center - Laurel

8:10 - 9:10 NPS COASTAL ISSUES AND NEEDS
Carl Zimmerman (Assateague Island National Seashore, MD)
David Manski (Acadia National Park, ME)
Michael Rikard (Cape Lookout National Seashore, NC)
Steve Cinnamon (National Lakeshores, Midwest Regional Office)

9:10 - 9:40 FWS REFUGE ISSUES AND NEEDS
Janith Taylor
US Fish and Wildlife Service, Region 5

9:40 - 10:00 Break

10:00 - 10:40 FWS COASTAL PROGRAMS
Jay Hestbeck
US Fish and Wildlife Service, Region 5

10:40 - 10:50 CONTAMINANTS ISSUES RELATED TO NPS AND FWS UNITS
Barnett Rattner
USGS Patuxent Wildlife Research Center - Laurel

Symposium Summary

10:50 - 11 SUMMARY AND CHARGE FOR THE WORKGROUP
Hilary Neckles
USGS Patuxent Wildlife Research Center - Augusta

1:30p - 4:40 COASTAL BREAKOUT SESSION
Continued discussion of coastal issues

Organizers: James Allen, Janet Keough, Hilary Neckles, Charles Roman
USGS Patuxent Wildlife Research Center

NUTRIENT ENRICHMENT OF COASTAL SYSTEMS

Issues

Increasing world population and continued settlement of the coastal zone is causing nutrient enrichment of coastal ecosystems worldwide. Residential, agricultural, and urban development associated with burgeoning coastal populations has resulted in increased nutrient levels of both surface and ground water supplies. Anthropogenic sources of nutrient loading include septic systems, sewage treatment plants, and fertilizer application. Atmospheric deposition of nitrogen from fuel emissions also contributes to nutrient enrichment of coastal waters, as does mineralization of organic matter inputs from agriculture and aquaculture operations, sewage waste water, and industrial effluents. Excessive nutrient enrichment causes changes in the structure and function of coastal ecosystems. Common ecosystem responses include increased algal growth, increased community metabolism, and decreased dissolved oxygen concentrations. Ultimate changes in ecosystem structure include shifts in the dominant primary producers and alterations of communities of benthos, shell- and finfish, and higher consumers.

Research Needs Relevant to Resource Management

Quantify nutrient loading to coastal waters from surface water, ground water, and atmospheric sources.

Develop models to predict nutrient loading from easily measurable parameters within developed and undeveloped watersheds.

Determine responses of coastal ecosystems to nutrient loading and identify thresholds for specific habitat responses.

Quantify responses of higher trophic levels to coastal nutrient enrichment.

Determine adequate buffer distances adjacent to upland development projects to protect wetland and estuarine habitats from excessive nutrient inputs.

Quantify the cumulative effects of localized point- and non-point source nutrient inputs on coastal watersheds.

PHYSICAL ALTERATIONS OF COASTAL HABITATS

Issues

Historically, human activities have altered coastal vegetated environments through both direct and indirect mechanisms. Direct physical alterations to salt marsh and seagrass habitats include sediment fill associated with upland development, storm protection, or dredge spoil disposal; sediment removal associated with ditching or dredging projects; and physical disturbance from vessels and aquaculture operations. Indirect alterations result from disruptions to physical processes that contribute to maintaining ecosystem structure and function. Examples of such indirect habitat alterations include restriction of tidal flow with dams, causeways, undersized culverts, and other obstructions; changes in freshwater inputs due to dams, sewer and storm drain outfalls, and other types of upland development; and stabilization of shorelines with groins, jetties, and seawalls. Direct and indirect alterations operate at multiple scales, from the level of individual plants to watersheds. In many cases the long-term and cumulative impacts on the structure, function, and sustainability of coastal habitats are unknown. This type of information is needed to guide restoration efforts and predict the outcomes of specific restoration actions. Ultimately, best management practices must be defined to minimize negative effects of surrounding land use on coastal wetland and estuarine habitats.

Research Needs Relevant to Resource Management

Determine the long-term impacts of anthropogenic physical disturbance on the structure, function, and sustainability of coastal habitats

Evaluate the cumulative effects of small, incremental alterations on coastal habitats

Quantify ecosystem responses to various habitat restoration and enhancement practices

Identify ecological indicators, standards, and criteria for evaluating the success of restoration efforts

Identify immediate threats to living resources from recreational and commercial activities in the coastal zone (e.g. personal watercraft, tour boats, commercial fishing practices)

Quantify the causal relationships between physical habitat alterations and detrimental effects of invasive species

Identify critical habitat conditions to protect, restore, and manage rare species that are threatened by physical alterations to coastal ecosystems

LONG-TERM MONITORING AND RESEARCH

ISSUES

Biological and physical structures and processes in the coastal zone are driven to a great extent by long-term and large-scale climate- and ocean- related phenomena. Seasonal and annual variability in storms, ocean temperature, erosion/deposition patterns, shoreline development, and plant and animal community development and succession, are examples of coastal processes that require long-term records to understand. Layered over regional processes are local, human developments, such as revetments, channel dredging, introduction of species, and the like; coastal ecosystems respond to such human interventions over the course of years. Understanding long-term phenomena requires a knowledge of ecosystem variation at many scales - seasonal, annual, interannual, decadal and longer - in order to conserve and manage coastal resources at the appropriate scale. Too often, we mistake interannual variation for effects of human impacts or, at minimum, cannot separate human impacts from natural variation. Long-term data can assist us in separating local from regional and anthropogenic from natural effects.

Coastal ecosystem managers in the Department of Interior and other agencies need to be able to address their management needs at the appropriate scale and distinguish long-term trends from short-term natural variation. Managers need to target efforts on trends that can be managed and improved and to recognize ecosystem responses to long-term effects, such as sea-level rise, that cannot be controlled but may be accommodated. Long-term studies and long-term monitoring can provide managers with the necessary information on variation, scale and trends.

LONG-TERM SCIENCE APPROACHES TO SUPPORT RESOURCE MANAGEMENT

- Expand programs within USGS to aid DOI Partners in long-term monitoring and assessment, addressing individual large units or complexes of units

- Provide incentives for scientists to participate in monitoring programs with encouragement, funding, opportunities for data analysis, and publications on long-term data sets

- Host a series of workshops with Partner Bureaus on the topic of long-term monitoring and analysis, including setting measurable goals and objectives, identification of monitoring indicators, approaches to data analysis, and using data in adaptive management

- Establish a Science Advisory Board for individual or complexes of National Parks and National Wildlife Refuges to assist with design and review of scientific research and monitoring

- Support long-term GIS platforms for National Parks, Wildlife Refuges, and other DOI management units

- Develop a program to acquire LIDAR data for every coastal park and refuge every 3-5 years and provide GIS analytical support

APPENDIX - DOI SCIENCE INFORMATION NEEDS

NATIONAL PARK SERVICE

Assateague Island National Seashore

Carl Zimmerman
National Park Service
Assateague Island National Seashore
7206 National Seashore Lane
Berlin, MD 21811
(410) 641-1443 x 213

1. Threats to estuarine water quality from adjacent land use practices and development

Issue: Runoff from residential and agricultural lands adjacent to park may threaten aquatic resources in the park.

Information needs:

- Hydrologic and water quality model
- Response of fisheries to environmental conditions
- Atmospheric deposition data
- Chemical contaminants in living resources
- Remote sensing tools
- Nutrient reduction tools

2. Impacts to coastal processes from adjacent navigation project (Ocean City Inlet)

Issue: A jetty blocks longshore transport of sediment so that the shoreline down-drift of the jetty is sediment starved. A mitigation project involves moving sediment from one side of the inlet to the other.

Information needs:

- Automation of geomorphic change data analysis
- Post-mitigation habitat assessment
- Post-mitigation rare, threatened, and endangered species assessment

3. Protection and management of rare, threatened, and endangered species

Issue: Information on the biology and ecology of rare, threatened, and endangered species is needed to enhance conservation efforts.
Information needs:

- Rare species survey
- Seabeach Amaranth reintroduction strategy
- Tiger beetle (*Cicindela* sp.) biology and impact mitigation strategies
- Piping plover banding/marking to determine critical habitat conditions

4. Impacts to island habitats from non-native species

Issue: Several non-native species potentially threaten island ecosystems. One species (feral horses) is actively managed to maintain a low population size.

Information needs:

- Census methods for Sika Deer
- Genetic variability in feral horse populations
- Nutria surveillance
- Impacts of horses on freshwater ponds
- Sika Deer grazing effects

5. Threats from recreational and commercial activities within park boundaries

Issue: Assateague Island National Seashore receives heavy beach use; some areas allow ORVs and some are restricted to foot traffic. Commercial fishing (hydraulic clamming) also occurs within Park boundaries.

Information needs:

- Assess benefits to submerged Aquatic vegetation (SAV) of Ano-take@ sanctuary (no clamming zones)
- Personal watercraft effects
- Fisheries catch and effort data
- Hydraulic clamming impacts on SAV
- Fisheries management plans

6. Other issues

Information needs:

- Baseline inventories - invertebrates, groundwater
- Long-term monitoring program development - groundwater, herptiles
- Mosquito ditch restoration

Acadia National Park

David Manski
National Park Service
Acadia National Park
P.O. Box 177
Bar Harbor, ME 04609

1. Air pollution

Issue: Acadia National Park is a Class 1 airshed under the Clean Air Act. Because of Acadia=s unique location in relation to patterns of continental air flow the Park is a recipient of much air pollution. Determining the biological ramifications of airborne pollutants, including ozone, sulfur dioxide, nitrogen oxides, volatile organic compounds, mercury, and acid precipitation on Park ecosystems is a high priority.

Information needs:

- How does long-term ozone exposure affect plant genetics and communities?
- How do elevated mercury concentrations in Park fish and wildlife affect productivity and behavior?
- Do PCB contaminant burdens in Park bald eagles change over time?
- What other atmospherically transported toxic substances pose public health and/or ecological risks to Park visitors and natural resources (e.g., dioxins)?
- How do Park watersheds, forests, and estuaries respond to nitrogen deposition?
- What are the effects of episodic acidification on stream biota?
- How does fire influence the fate of atmospherically deposited metals and organic compounds?
- Are Park biota at risk from UV exposure?

2. Increasing development

Issue: Continued residential development adjacent to the Park boundary potentially threatens Park resources.

Information needs:

- How do Park coastal wetlands respond to increasing amounts of septic waste and yard fertilizers associated with new and expanding residential development on Mount Desert Island?
- What are the ecological consequences for Park plant and animal populations of increasing habitat fragmentation outside the Park boundary?

3. Conservation of biological diversity - plants

Issue: Acadia supports a very diverse flora due to its location at the intersection of two biogeographic regions and its topography. Many plant species in the Park are considered locally rare and several are listed as globally rare. Although inventories of Park flora have been completed, basic information on factors controlling the distribution and abundance of rare species and communities is lacking. Invasive plant species pose a significant threat to native plant communities in the Park.

Information needs:

- Some of the rarest Park plants are abundant in other parts of Maine or New England. Should the NPS be concerned about their rarity in Acadia National Park? What is the Park=s role in protecting rare plants?
- Should we be trying to protect certain plant populations when their rarity may be related to a natural extinction

or the result of vegetation succession?
- What are the statistically appropriate long-term monitoring techniques for small populations of rare plants?
- What are cost-effective techniques to control highly invasive non-native plants at the Park, such as Japanese barberry, alder buckthorn, and oriental bittersweet?
- How do sub-alpine plant communities and boreal forests at Acadia respond to anticipated changes in climate?
- What are the long-term effects of browsing on plant succession in a post-fire forest environment?

4. Conservation of biological diversity - animals

Issue: Good baseline inventory data exist on some groups of animals, including large mammals, birds, and invertebrates. The historic invertebrate records are particularly extensive, from nearly 30-years of invertebrate surveys in the first part of this century. Baseline data on other animal groups is lacking (estuarine and anadromous fish) or incomplete (amphibians and reptiles). Information on the ecology of various species is also needed.

Information needs:

- Have there been changes in the invertebrate fauna over the last 75 years?
- What are the effects of landscape disturbance on native pollinators?
- What are the most cost-effective techniques to monitor changes in terrestrial invertebrates?
- How do harlequin duck survival rates vary among sexes, age classes, and seasons?
- What is the status of common eiders nesting on Park offshore islands?
- What birds nest in Park estuaries? What role do Park estuaries play as staging habitat for migratory birds?
- What raptors nest in the Park?
- How have beaver populations responded to forest succession?
- What are the effects of fish stocking on native freshwater aquatic ecosystems?

5. Social science

Issue: Acadia receives 3 million visitors annually. Information needs focus on maintaining high quality visitor experiences while protecting park resources.

Information needs:

- What are the most effective interpretive techniques to educate visitors about important Park natural resource issues?
- What are appropriate visitor carrying capacities for sensitive Park habitats such as mountain summits and offshore islands?
- What are appropriate visitor carrying capacities for the Schoodic Peninsula and Isle au Haut?
- How satisfied are visitors with the Park=s new shuttle bus system?

Apostle Islands National Lakeshore

Jerry Banta, Superintendent
Julie Van Stappen, Resource Management specialist
Route 1, Box 4
Bayfield, WI 54814
(715) 779-3397

Issues and Information Needs:

- Coastal dynamics and sand deposition -- effects on facilities
- Contaminants -- bioaccumulation in eagles and furbearers
- Commercial fishing waste and bioaccumulation

Indiana Dunes National Lakeshore

Dale Engquist, Superintendent
Bob Daum, Resource Management Specialist
1100 N. Mineral Springs Road
Porter, IN 46304
(219) 926-7561

Issues and Information Needs:
- Create standardized E. coli monitoring for NPS open water swimming beaches
- Create standardized protocols to monitor white-tailed deer populations and impacts of deer on vegetation
- Determine best methods of controlling aggressive exotic vegetation
- Determine best methods of monitoring rare vegetation
- Study biological impacts, water quality impacts, and public reaction to personal watercraft in NPS areas that allow them
- Determine best methods for the vegetative restoration of a sedge meadow that has succeeded into a wet forest system once the unnatural drainage patterns (ditches) have been removed
- Examine the genotypes of selected isolated native plant species to determine the effects of fragmentation on their population
- Assist Park with shoreline erosion studies

Isle Royale National Park

Doug Barnard, Superintendent
Jack Oelfke, Chief, Resource Management
800 E. Lakeshore Drive
Houghton, MI 49931-1895
(906) 482-0986

Issues and Information Needs:
- Impacts of motorized recreation on other recreationists
- Identification of coastal brook trout habitat
- Impacts of hydrocarbon emissions from boats

Pictured Rocks National Lakeshore

Grant Petersen, Superintendent
Brian Kenner, Chief, Resource Management
P.O. Box 40
N8391 Sand Point Road
Munsing, MI 49862
(906) 387-2607

Issues and Information Needs:
- Impacts of motorized recreation on other recreationists
- Impacts of boats on loons, disturbance from tour boats
- Monitoring of colony nesting birds

- Human impacts on colony nesting birds, effects of tour boat operations (e.g. feeding)

Sleeping Bear Dunes National Lakeshore

Ivan Miller, Superintendent
Steve Yancho, Resource Management specialist
9922 Front Street
Empire, MI 49630-9797
(616) 326-5134

Issues and Information Needs:

- Coastal dynamics and dune failure
- Piping plovers - habitat identification, predation, nest success
- User conflict - motorized recreation, impacts on other recreationists
- Dune erosion/geomorphology
- Timing of precipitation and erosion
- Water quality

Southeastern Coastal Parks (Cape Hatteras National Seashore, Cape Lookout National Seashore, Cumberland Island National Seashore, Canaveral National Seashore, Biscayne National Park)

Michael Rikard
Cape Lookout National Seashore
131 Charles Street
Harkers Island, NC 28531
(252) 728-2250

1. Physical coastal processes

Issue: Dredging, groins, jetties, and beach nourishment programs alter natural sediment transport processes and affect Park resources.

Information needs:

- Oregon Inlet (Cape Hatteras National Seashore)
- Cape Hatteras lighthouse
- Drum Inlet (Cape Lookout National Seashore)
- Effects of Naval Base operations on Cumberland Island National Seashore
- Historic structures (Fort Sumpter and Port Pulaski)

Water quality

Issue: Activities adjacent to Park boundaries may affect Park aquatic resources.

Information needs:

- Biscayne National Park
- Canaveral Mosquito Lagoon
- Effects of commercial fishing

Ground water withdrawal

Issue: Withdrawal of ground water in support of adjacent developed areas may threaten Park resources.

Information needs:

- Cape Hatteras National Seashore

Protection and management of rare, threatened, and endangered species

Issue: Information on the biology and ecology of rare, threatened, and endangered species is needed to enhance conservation efforts.

Information needs:
- Sea turtles vs. native raccoons
- Piping plovers
- Sea beach amaranth

Impacts to island habitats from non-native species

Issue: Several non-native or invasive species potentially threaten island ecosystems.

Information needs:
- Feral pigs at Cumberland Island National Seashore
- Feral horses at Cumberland Island and Cape Lookout National Seashores
- Feral cats
- Nutria
- Plants - Phragmites

Visitor use

Issue: Recreational activities may threaten Park resources.

Information needs:
- Effects of off-road vehicles
- Effects of personal watercraft
- Effects of hunting and fishing

Inventory and monitoring of Park resources

Issue: Basic information on the status and trends of Park resources is needed to guide conservation and management decisions.

Information needs:
- Coastal processes
- Vegetation
- Wildlife

US FISH AND WILDLIFE SERVICE

National Wildlife Refuges in the Northeast

Jan Taylor
US Fish and Wildlife Service
336 Nimble Hill Road
Newington, MH 03801
(603) 431-5581

Mosquito control issues

Issue: Application of chemicals for mosquito control may affect non-target aquatic invertebrates and other wildlife. Past marsh manipulation for mosquito control has altered the structure of saltmarsh habitat.

Information needs:

- Effects of mosquito control chemicals on shorebird, waterfowl, and wading bird food resources
- Impacts of chemical application on other salt marsh wildlife such as saltmarsh sparrow and seaside sparrow
- Selection of appropriate management in response to past habitat alterations: restoration versus enhancement
- Effects of management on site selection by salt marsh wildlife

Coastal restoration techniques compatible with objectives for USFWS Trust Resources and mosquito control

Issue: Restoration activities in current use include Open Marsh Water Management (OMWM) as defined by the USFWS. Information on ecosystem responses of coastal wetlands to OMWM and other restoration activities is needed.

Information needs:

- Hydrologic, physical, and ecological responses to ditch-plugging
- Determination of standards and criteria for evaluating restoration success
- Coastal wetland tours for increased communication and training

Land use practices in the coastal zone

Issue: Increasing development, public use, and recreational interest in the coastal zone may threaten wildlife resources.

Information needs:

- Effects of horseshoe crab harvest on populations
- Lack of methods for monitoring horseshoe crabs
- Effects of bulk-heading projects
- Effects of recreational activities on coastal dependent birds during nesting and migration seasons is needed for Comprehensive Conservation Planning.
- Unknown buffer distances adjacent to upland development projects to protect tidal, riparian, and estuarine habitats.

Coastal migratory bird issues

Issue: Information on the biology and ecology of migratory birds is needed to enhance management and conservation efforts.

Information needs:

- Possible effects of herring and great black-backed gulls on piping plovers
- Identification of important foraging areas used by coastal birds, especially colonial species, that nest or roost on refuge lands
- Availability of fish stocks from one year to the next for colonial birds
- Effects of snow goose eat-outs

Ecological Services Programs in the Northeast

Susan Essig

US Fish and Wildlife Service
300 Westgate Center Drive
Hadley, MA 01035-9589
(413) 253-8611

1. Wildlife use of seasonally saturated wetlands on the coastal plain

Issue: From New Jersey south on the Atlantic Coast, the coastal plain is characterized by wet flatwoods dominated by loblolly pine and other species, including various hardwoods. Many of these wetlands are isolated and are not currently regulated under Federal law. USFWS has trust responsibilities for wetlands in general, and for recovery of the Delmarva fox squirrel, an endangered species that uses this particular type of wetlands.

Information needs:

- What species are at risk due to unregulated development of these wetlands?
- To what extend do wildlife rely on these drier-end wetlands?

2. Buffers for wildlife protection

Issue: Many wetland and riverine restoration projects are undertaken annually by the USFWS, NRCS, EPA, and US Army Corps of Engineers, both to improve the integrity of coastal watersheds and to mitigate for permitted wetland conversions. However, protocols do not exist for the types and widths of upland buffers that should be included in stream reforestation or wetland restoration projects.

Information needs:

- What are adequate sizes of buffers along wetlands and streams to support wildlife?
- How dependent are wetland wildlife on wetland buffers and stream corridor buffers?

3. Appropriate level of monitoring for wetland restoration or creation projects

Issue: Despite the investment of Federal funding in wetland restoration and, to a lesser amount, creation, the preponderance of effort is expended on determining areas suitable for restoration, securing any necessary permits, and the actual restoration activity. Very little attention has been given to monitoring in either the restoration or regulatory (i.e. restoration as compensatory mitigation) arenas. It is critical that an appropriate level of monitoring be instituted to ensure that projects are meeting their scientific objectives.

Information needs:

- What hydrologic indicators should be monitored to determine whether a restored wetland is recreating the lost functions and values of the original system?
- What vegetation indicators should be monitored to determine whether a restored wetland is recreating the lost functions and values of the original system?
- What is the appropriate longevity of a monitoring program?

4. Cumulative impacts of coastal development

Issue: Degradation of estuarine and nearshore habitats is a product of numerous small-scale development projects that incrementally affect water quality and aquatic resources. The cumulative impacts of such small-scale alterations are poorly understood.

Information needs:

- What are the cumulative effects of small-scale development such as septic systems, docks and pier construction,

and localized non-point source pollution on coastal watersheds and estuarine systems?

5. Essential components of watersheds

Issue: Coastal watersheds in the Northeast are generally degraded to varying extents. Indicators of general ecosystem health should be developed to help decision makers prioritize restoration projects.

Information needs:

- What are the characteristics of an ecologically healthy watershed?
- What characteristics must be maintained to sustain ecological health?

- To what extent can a watershed be degraded and still maintain ecological functions (i.e., can Aassimilative capacity@ be measured)?

6. Habitat requirements for living resources

Issue: The Chesapeake Bay Federal Interagency Program published AHabitat Requirements for Chesapeake Bay Living Resources@ in 1991. Since this time, similar characterizations have been done for other estuaries.

Information needs:

- Augment existing literature on species determined to be characteristic or indicator species of an estuary.

7. Species at risk

Issue: Proactive strategies are needed to reverse species= declines and preclude the need for listing under the Endangered Species Act.

Information needs:

- Ecology of juvenile Atlantic sturgeon
- Survey of Chesapeake Bay tributaries for Atlantic sturgeon
- Status of population of the rare skipper, known from only one marsh in Virginia.

- To what extent can a watershed be degraded and still maintain ecological functions (i.e., can Aassimilative capacity@ be measured)?

8. Habitat requirements for living resources

Issue: The Chesapeake Bay Federal Interagency Program published AHabitat Requirements for Chesapeake Bay Living Resources@ in 1991. Since this time, similar characterizations have been done for other estuaries.

Information needs:

- Augment existing literature on species determined to be characteristic or indicator species of an estuary.

9. Species at risk

Issue: Proactive strategies are needed to reverse species= declines and preclude the need for listing under the Endangered Species Act.

Information needs:

- Ecology of juvenile Atlantic sturgeon
- Survey of Chesapeake Bay tributaries for Atlantic sturgeon
- Status of population of the rare skipper, known from only one marsh in Virginia.

Document IV

COASTAL AND BARRIER NETWORK PARK RESOURCES AND SETTINGS

Assateague Island National Seashore (ASIS) encompasses more than 39,000 acres, more than half of which is comprised of oceanic and estuarine waters surrounding the Island. Located within a three-hour drive of the Washington/Baltimore/Philadelphia metropolitan area, the National Seashore hosted more than 1.8 million visitors in 1999. The natural resources showcased by the park include a diverse assemblage of aquatic and terrestrial wildlife (including the free-roaming feral horses for which Assateague is famous), vegetation communities, and geological features and physical processes reflecting the complexity of the land/sea interface along the Mid-Atlantic coast. The indigenous plant communities reflect the adaptive extremes necessary for survival on a barrier island, where exposure to salt spray, lack of freshwater, and shifting sands create a harsh and dynamic environment. Throughout the Seashore, the relationship of land and water is paramount.

Changing patterns of land use in the watershed of the coastal lagoons of ASIS threatens park water quality and biotic systems. Although park waters are considered to be in "good" condition at present, nearby estuaries with more extensive development are significantly degraded, primarily due to eutrophication from anthropogenic nutrient inputs. With a projected growth rate of >20% over the next 25 years, the potential for similar degradation of park waters is considered high. The ability to document changing estuarine conditions, including trends in submerged aquatic vegetation, fish, and benthic invertebrate community composition, is considered crucial towards influencing and mitigating local/regional development.

Since 1935, the federal navigation channel at Ocean City, MD has disrupted the natural sediment supply to Assateague Island, resulting in wholesale physical and biological changes. A comprehensive mitigation program has been developed involving both short term (one-time beach nourishment) and long term components (sediment bypassing). Implementation and management of these programs will require the ability to continuously evaluate island conditions, (including changes in the distribution and abundance of rare species), relevant physical processes, and the effects of restoration actions in order to optimize outcomes and ensure maximum compatibility with management objectives.

Portions of ASIS provide suitable habitat for a variety of state and federally listed species, both plants and animals. The known and perceived threats to these species vary in intensity, and include a range of causative factors including recreational activities, disruptions to natural coastal processes, and interactions with both native and non-native species. Certain high-profile species such as the piping plover are being actively managed, but others remain poorly understood and are largely ignored. In particular, rare resident plant and insect species, and transient bird species lack appropriate levels of documentation (presence/absence, distribution and abundance) threat mitigation, and assessment.

Non-native plant (especially Phragmites and Asiatic sand sedge) and animal species (feral horses, sika deer, nutria) present on Assateague Island are known to be having a significant impact on several of the primary vegetation communities occurring within ASIS. Documented effects include reduced health and reproductive capacity of certain key plant species, changes in species abundance and community composition, and loss of faunal biodiversity. The development of long-term management programs to mitigate the impacts of these species requires a variety of basic life history, distribution, and relative abundance data to guide decision-making and program implementation/evaluation.

Species and habitats at risk:

1. Submerged vascular plant species at risk from deteriorating estuarine water quality include: *Zostera marina* (eelgrass) and *Ruppia maritima* (widgeon grass).

2. Early successional, disturbance-driven beach habitat, and associated plant/animal species at risk from altered coastal processes and recreational activities including:

Amanthus pumilus (Seabeach Amaranthus)	federally threatened
Charadrius melodus (Piping Plover)	federally threatened
Polygonum glaucum (Seabeach Knotweed)	state endangered
Sesuvium maritimum (Sea-purslane	state endangered
Scleria verticillata (Whorled Nutrush)	state endangered

Cicindela dorsalis media (White Tiger Beetle) state endangered

3. Exotic Species with known or potential impacts on native species and habitats

Phragmites australis (Phragmites)	wetland communities
Carex kobomugi (Asiatic Sand Sedge)	dune communities
Cervus nippon (Sika Deer)	all plant communities
Myocastor coypus (Nutria)	wetland communities

4. Rare/sensitive habitats at risk from exotic species

Freshwater ponds and wetlands feral horses, nutria

5. Species or communities at risk from recreational activities including off-road vehicle use:

Migratory shorebirds using ocean beach as "stopover habitat"
Ocean nearshore benthic macroinvertebrate community
Migratory songbirds using Island as "stopover habitat"

Cape Cod National Seashore (CACO)

CACO preserves approximately 44,600 acres of uplands, wetlands and tidal lands located on Outer Cape Cod, Massachusetts. A mosaic of natural and cultural resources, which are the result of dynamic natural processes and at least 9,000 years of human activity, characterizes CACO.

The natural terrain contains an exceptional array of coastal communities, including pitch pine/oak forest, heathlands (nearly the entire eastern U.S. distribution of heathlands is restricted to fragments on the Outer Cape and in coastal Maine), dunes and coastal plain pond shores. There is also a wide diversity of aquatic and marine habitats, such as kettle ponds, cedar swamps, vernal pools), drowned river valley salt marshes, back barrier salt marshes, barrier spits and inter-tidal mudflats. These habitats support numerous state, federal, and globally rare, threatened, and endangered species of plants, invertebrates, and vertebrates. For many, CACO provides some of the best quality remaining habitat and offers prime opportunities for their preservation regionally. The great Outer Beach also provides outstanding examples of dynamic geomorphic processes.

Natural resource management objectives are to:

1. Allow natural shoreline processes to take place unimpeded, while also counteracting human-caused disturbances

2. Protect ground and surface water quality and quantity, as well as adjacent wetlands

3. Restore the natural hydrography and ecology of estuaries in consultation with affected municipalities

4. Manage native biotic resources by allowing natural processes to continue unimpeded except where appropriate to selectively manage for native biological diversity or rare, threatened, or endangered species or communities

5. Manage special uses affecting wildlife populations and other biotic resources to minimize ecosystem impacts and to sustain natural processes

6. Engage in cooperative regional efforts to improve air quality

7. Facilitate protection and management of natural resources through the implementation of a comprehensive and long-term program of ecological monitoring and research

Over 800 species of plants are extant in CACO in a wide range of community types including heathlands, fresh and salt water wetlands, tidal marshes, upland forests, beaches, dunes and grasslands.
CACO's natural resource management program faces a number of increasingly complex and challenging issues. These include: 1) impacts of adjacent development on groundwater quantity and quality; 2) accelerated rates of freshwater and coastal marine eutrophication; 3) impacts of recreation on natural resources; 4) effects of landscape

changes since European settlement; 5) protection and restoration of Federal and/or State listed rare species and communities; 6) consumptive uses of resources, 7) air pollution and, 8) sea level rise.

Given these issues and the legislative mandate of the NPS to maintain native ecosystems for the present and future enjoyment and education of the public, the resource management program at CACO will be framed by three fundamental tasks: 1) to develop a foundation of knowledge about ecosystems of the Outer Cape peninsula in the context of man's increasing influence over the past 300 years; 2) to conduct and coordinate studies to clarify management questions and to identify appropriate solutions to sustain native ecosystem functions; and 3) to implement appropriate restoration and/or management actions to mitigate anthropogenic threats.

The current program has attempted to address these objectives through multi-disciplinary work toward an interpretation of the landscape ecology of Outer Cape Cod. The effects of internal and external human development and recreation since CACO's establishment (1961) have increased exponentially and much of the natural resource management effort has also focused on buffering the effects of an increasingly abundant and mobile northeastern society. Yet despite many accomplishments, current natural resource funding levels at CACO do not provide for the resolution of critical resource threats; baseline resource studies remain to be completed and recommendations from many studies cannot be implemented. Future natural resource activities and funding needs are focused on ten key program areas (not listed in priority):

Federal and/or State listed Rare Species: The presence of fourteen federal and over sixty state listed threatened and endangered plant and animal species necessitates the mapping of habitats, monitoring of populations, and implementing restoration and education activities. NPS policies give high priority to protection and management of rare species. Except for managing piping plovers and terns, CACO has given only minimal attention to Federal and/or State listed rare species.

Kettle Ponds: Concentrated public recreation, extensive shoreline development and multiple jurisdictions all threaten the integrity of these freshwater communities. An integrated research, monitoring, restoration and education program is needed to detect and mitigate resource impacts effectively in these fragile and overused pond environments.

Consumptive Uses of Biota: Fishing, shellfishing and hunting are legislatively authorized activities that continue to grow. Little information exists about harvest levels or impacts on harvested and non-target species. Baseline inventories and monitoring of these harvested species and their habitats are needed to enhance their long-term protection.

Geomorphic Processes: Geomorphic changes on the coast and dune areas have not been monitored systematically during the last fifteen years. Important information on shoreline retreat, accretion and inlet migration is lacking. Significant pedestrian impacts on dunes and bluffs also exist, but have never been quantified. Surveys and long-term monitoring need to be implemented to provide baseline information about these processes and to differentiate anthropogenic from natural caused changes. CACO’s prototype Inventory and Monitoring Program has begun to assess these geomorphic processes.

Air Quality: Current monitoring does not include particulate and SO2 sampling that may be impacting natural resources. Without long-term data acquisition and evaluation, expected subtle impacts to terrestrial and aquatic resources will go undetected.

Non-Native Species: Since European settlement, numerous non-native species have been introduced on the Outer Cape. Several are known to be invasive and there are a number of sites in the park where these aliens are becoming dominant. However, there is a general lack of baseline data on their distribution, abundance, and impacts on native biota and physical processes.

Groundwater and Estuarine Water Quality: The identification, assessment and resolution of water quality issues, ranging from landfill leachate and groundwater extraction to wetland protection, will improve effective water quality preservation and threat mitigation. The addition of staff hydrological expertise and improved laboratory support are

essential to accomplishing this objective. Municipal groundwater withdrawal either within or adjacent to the park is a current threat in the Pamet aquifer and a potential concern elsewhere.

Human-Altered Systems: Over 300 years of European habitation on the Outer Cape has dramatically altered many habitats, including the Province Lands dunes and salt marshes. In order to facilitate the restoration of these systems, an integrated research, monitoring, planning and interpretation program is needed.

Baseline Inventories and Monitoring: Inventories are fragmentary for most biota, except for species of special and current interest. Baseline studies are needed to guide future management actions and to ensure the long-term preservation of a diversity of species.

Vegetation: Plant communities are affected by a variety of natural and human-caused events, including fire, succession, air quality, recreation, and alien species. Preservation of a diversified landscape within the context of intense historical land use requires a comprehensive research, monitoring, mitigation and education program.

Species of Concern

25 Federal T&E animals (mostly pelagic marine) Piping Plover most important as mgmt issue here
No federal plants.
42 state listed animals, most important ones (i.e. reside in park) associated with beach, marsh, vernal ponds, heathlands and grassland habitats.
17 plants. Most associated with wetland, heath/grassland, or beach communities.
(This list of species will be provided at the meeting)

b. Habitats of Concern include

Salt Marsh/Tidal Flats
Heathlands
Coastal Grasslands
Kettle Ponds
Vernal Ponds
Red Maple and White Cedar swamps

c. Non-native species. Exact data are lacking but probably 25% + of plant species occurring at CACO are non-native. Many are highly invasive are appear to occupy significant amount of area. The most obvious/predominant include:

Black Locust
Multi-flora rose
Autumn Olive
Japanese Honeysuckle
Oriental Bittersweet
Phragmites
Purple Loosestrife

Species and Resources Extracted

a. Data on quantities are not well known, except for municipal water

Groundwater-by municipalities and private landowners
Shellfishing-managed by towns per enabling legislation-commercial and recreational
Hunting-waterfowl and the usual upland game species
Fishing-Sportfishing in fresh and salt water. Kettle ponds include stocked non-natives

Fruits/Fungi-blueberry, beach plum, and large quantities of mushrooms in fall

b. Habitats Impacted by Removal

Groundwater extraction threatens freshwater habitats, especially vernal ponds, swamps, and marshes. Shellfishing-disturbs wildlife use of tidal flats.

3. Monitoring

Development, testing, and operational implementation of monitoring protocols continued in 1999, with different protocols at different stages in this progression. Kettle pond limnology, piping plover and terns, and air quality (ozone and wet deposition) are operational. Estuarine nutrients and nekton, shoreline change, surface and groundwater hydrology, and estuarine sediment contaminants have been field-tested. They will be finalized upon analysis of data to determine optimal temporal and spatial scope. Protocols for meteorology, vegetation, beach invertebrates, freshwater fish, avian productivity, marsh birds and migratory water birds, small and large mammals are currently or will soon be field-tested. Protocols for amphibians, land birds, land use and visitor use will be developed in 2000.

4. Management Issues

Aquatic/Estuarine Issues

-Cultural Eutrophication of Kettle Ponds and Salt Marsh
-Historic Diking of Salt Marshes/need for restoration
-Mosquitoes/Political Pressure for Mosquito Management
-Groundwater Withdrawal and impacts to wetland veg and animal life
-Recreational trampling of kettle pond shoreline vegetation
-Aquaculture-push by local town to force this onto park-impacts to habitat? plus disturbance to birds
-Horseshoe Crab Harvesting

Development Associated Issues
Residential Development within and especially immediately adjacent to the park, leading to
-Habitat Fragmentation/increasing road kills on micro-vertebrates
-Increased pet predation on native wildlife
-Groundwater withdrawal and septic inputs
-Increased levels of human activity/disturbance

Landscape/Vegetation Issues
Landscape significantly altered by Europeans over nearly 4 centuries.
-Much of vegetation is a post-agrarian mix of native and alien species
-Alien species dominate in many places
-Even in native dominated vegetation, community structure does not represent natural condition
-Fire suppression impacts
-Loss of grassland/heathland habitats-determining relative amounts that were natural versus anthropogenic

Recreational Impacts
-Park is heavily visited in summer. Year round use is increasing.
-Numerous social trails/trampling of vegetation/mountain bike trails
-Jet Skis
-Pets off leash/hunting dogs
-Releasing non-native pheasants for put/take hunting
-Trampling of dune vegetation

Net result of all this visitation/use is that much of park (especially shoreline and salt marsh habitats) becomes unavailable to/of marginal value to disturbance sensitive wildlife species such as piping plover, terns, seals, migrating waterfowl and shorebirds.

Shoreline Dynamics
-Accelerated rates of erosion due to recreational impacts
-Dredging/deposition of spoil

Preservation of Native Species Biodiversity
-Determining extent to which all of the issues listed above contribute to this issue
-Except for federal listed species, status and distribution of most state-listed species is unknown, out of date, incomplete.
-Many other species of formerly common species appear to be declining. Data on their status and distribution are lacking. Others appear to have disappeared in recent years.
-Loss of heathland grassland habitat and declines in associated wildlife species.

Scientific Name	Common Name	Status	Remarks
Vertebrates (listed in taxonomic order)			
Hemidactylium scutatum	Four-toed salamander	SC	
Scaphiopus holbrookii	Spadefoot toad	ST	
Clemmys guttata	Spotted turtle	SC	
Malaclemys terrapin terrapin	Northern diamondback terrapin	ST	
Terrapene carolina	Box turtle	SC	
Gavia immer	Common loon	SC	Migrant
Podilymbus podiceps	Pied-billed grebe	SE	
Oceanodroma leucorhoa	Leach=s storm petrel	SE	Very rare in summer; rare in fall
Botaurus lentiginosus	American bittern	SE	
Ixobrychus exilis	Least bittern	SE	Rare
Accipiter cooperii	Cooper=s hawk	SC	
Accipiter striatus	Sharp-shinned hawk	SC	
Circus cyaneus	Northern harrier	ST	
Gallinula chloropus	Common moorhen	SC	Rare
Rallus elegans	King rail	ST	Rare
Bartramia longicauda	Upland sandpiper	SE	Rare migrant
Sterna antillarum	Least tern	SC	
Sterna hirundo	Common tern	SC	
Sterna paradisaea	Arctic tern	SC	
Tyto alba	Common barn owl	SC	Rare
Asio flammeus	Short-eared owl	SE	
Asio otus	Long-eared owl	SC	Rare
Cistothorus platensis	Sedge wren	SE	Rare
Lanius ludovicianus	Loggerhead shrike	SE	Rare migrant
Pooecetes graminens	Vesper sparrow	ST	
Ammodramus henslowii	Henslow=s sparrow	SE	
Ammodramus savannarum	Grasshopper sparrow	ST	Rare
Parula americana	Northern parula	ST	Migrant
Dendroica striata	Blackpoll warbler	SC	Migrant
Oporornis philadelphia	Mourning warbler	SC	Migrant
Vermivora chrysoptera	Golden-winged warbler	SE	Rare migrant
Halichoerus grypus	Gray seal	SC	Federally protected (MMPA)
Invertebrates			
Ferrissia walkeri	Walker=s limpet	SC	
Enallagma laterale	New England bluet	SC	
Enallagma recurvatum	Pine barrens bluet	ST	
Abagrotis crumbi benjamini	Coastal heathland cutworm	SC	
Apharetra purpurea	Blueberry sallow	SC	
Catocala herodias gerhardi	Gerard=s underwing moth	ST	
Cingilia catenaria	Chain dot geometer	SC	
Fixsenia ontario	Northern hairstreak	SC	

Family	Scientific Name	Common Name	Observed at Cape Cod National Seashore
Endangered Species			
Boraginaceae (Borages)	*Mertensia maritima*	Oysterleaf	Yes
Cyperaceae (Sedges)	*Carex striata* var. *brevis*	Walter=s sedge	Yes
	Eleocharis obtusa var. *ovata*	Ovate spike-sedge	Historic recording
Juncaceae (Rushes)	*Juncus debilis*	Weak rush	Yes
Poaceae (Grasses)	*Elymus mollis*	Sea Lyme-grass	Historic recording
Threatened Species			
Araceae (Arums)	*Orontium aquaticum*	Golden club	Yes
Cactaceae (Cacti)	*Opuntia humifusa*	Prickly pear	Yes
Cyperaceae (Sedges)	*Carex oligosperma*	Few-fruited sedge	Yes
Lentibulariaceae (Bladderworts)	*Utricularia fibrosa*	Fibrous bladderwort	Yes
Ophioplossaceae (Grape Ferns)	*Ophioglossum pusillum*	Adder=s-tongue fern	Historic recordiing
Poaceae (Grasses)	*Aristida purpurascens*	Purple needlegrass	Yes
	Sphenopholis pennsylvanica	Swamp oats	Yes
Species of Special Concern			
Alismataceae (Arrowheads)	*Sagittaria teres*	Terete (slender) arrowhead	Yes
Cistaceae (Rockroses, Pinweeds)	*Helianthemum dumosum*	Bushy rockrose	Yes
Cyperaceae (Sedges)	*Rhynchospora scirpoides*	Long-beaked bald-sedge	Yes
Empetraceae (Crowberries)	*Corema conradii*	Broom crowberry	Yes
Iridaceae (Irises)	*Sisyrinchium arenicola*	Sandplain blue-eyed grass	Historic recording
Lentibulariaceae (Bladderworts)	*Utricularia subulata*	Subulate bladderwort	Yes
Poaceae (Grasses)	*Dichanthelium commonsianum*	Common=s panic-grass	Yes
	Spartina cynosuroides	Salt reedgrass	Yes

Scientific Name	Common Name	Status	Remarks
Hemileuca maia	Coastal barrens buckmoth	ST	
Papaipema sulphurata	Decodon borer moth	ST	

SOURCE: Massachusetts Natural Heritage and Endangered Species Program.
Note: Not listed are state-listed species that are also federally listed, including the bald eagle, peregrine falcon, eskimo curlew, roseate tern, and sperm, finback, sei, blue, humpback, and right whales (all state-listed as endangered); and the piping plover and northeastern beach tiger beetle (state-listed as threatened). The gray seal appears on both lists.
ST = State Threatened SE = State Endangered
SC = Species of Special Concern Rare = Species does not occur annually; when found, occurs in small numbers (<5 individuals).

Scientific Name	Common Name	Observed at Cape Cod National Seashore	Status		Remarks
			USFWS	NMFS	
Vertebrates (listed in taxonomic order)*					
Caretta caretta	Loggerhead turtle	Yes	FT	FT	
Chelonia mydas	Green turtle	NMFS record	FT	FE	Rare; the Florida nesting population is endangered; the Caribbean nesting population, threatened.
Eretmochelys imbricata	Hawksbill turtle	Yes	FE	FE	Rare.
Lepidochelys kempii	Atlantic ridley turtle	Yes	FE	FE	
Dermochelys coriacea	Leatherback turtle	Yes	FE	FE	
Haliaeetus leucocephalus	Bald eagle	Yes	FE		Migratory; state-listed as endangered.
Falco peregrinus anatum	Peregrine falcon	Yes	FE		Migratory; state-listed as endangered.
Charadrius melodus	Piping plover	Yes	FT		May 1995 recovery plan; state-listed as threatened.
Numenius borealis	Eskimo curlew	Yes	FE		Migrant; nearly extinct; state-listed as endangered.
Sterna dougallii dougallii	Roseate tern	Yes	FE		State-listed as endangered.
Phoca vitulina	Harbor seal	Yes		MM	Common in winter.
Pagophilus groenlandicus	Harp seal	Yes		MM	Rare.
Halichoerus grypus	Gray seal	Yes		MM	State-listed as of special concern.
Cystophora cristata	Hooded seal	Yes		MM	Rare.
Physeter catodon / macrocephalus	Sperm whale	NMFS record	FE	FE	Rarely found at depths less than 600N; state-listed as endangered.
Lagenorhynchus acutus	Atlantic white-sided dolphin	Yes		MM	
Orcinus orca	Orca	Yes		MM	Rare.
Globicephela melaena	Pilot whale	Yes		MM	
Phocoena phocoena	Harbor porpoise	Yes		P	NMFS has proposed for listing under Endangered Species Act.
Balaenoptera physalus	Finback whale	Yes	FE	FE	State-listed as endangered.
Balaenoptera borealis	Sei whale	Yes	FE	FE	State-listed as endangered.
Balaenoptera acutorostrata	Minke whale	Yes		MM	
Balaenoptera musculus	Blue whale	NMFS record	FE	FE	Rare in shallow coastal waters; state-listed as endangered.
Megaptera novaeangliae	Humpback whale	Yes	FE	FE	State-listed as endangered.
Eubalaena glacialis	Right whale	Yes	FE	FE	Designated critical habitat includes a portion of the seashore; state-listed as endangered.

Scientific Name	Common Name	Observed at Cape Cod National Seashore	Status		Remarks
			USFWS	NMFS	
Invertebrates					
Cicindela dorsalis dorsalis	Northeastern beach tiger beetle	H	FT		April 1992 draft recovery plan; state-listed as threatened.

* Most migratory birds found at Cape Cod NLS are also protected under the Migratory Bird Treaty Act.

NMFS = National Marine Fisheries Service. USFWS = United States Fish and Wildlife Service.
FE = Federally listed as endangered. FT = Federally listed as threatened.
MM = Protected under Marine Mammal Protection Act. P = Proposed for listing by NMFS.
H = Historic record of sighting. Rare = Species not found annually; when found, occurs in small numbers (<5 individuals).

Colonial National Historical Park (COLO)

Colonial National Historical Park's 9327 acres are within the coastal plain of Tidewater Virginia. The entire park has a direct hydrological link to the Chesapeake Bay. Most of the park extends along either the York or James Rivers, two of the largest rivers contiguous to the western shore of the Chesapeake Bay. In addition, numerous streams, creeks and ponds flow through the park and feed directly into one of these two rivers. Mixed pine and hardwood forests cover most of the park. Substantial acreage of both tidal and nontidal wetlands and open fields also exist. The park is within the boundaries of the counties of York, James City, Gloucester, Surry, the City of Williamsburg and Virginia Beach.

Topography

Parklands have a varying topography, which takes in low-lying wetlands, ravines and terraces up to 120 feet (38 meters) above mean sea level (MSL).

Water Resources

More than 30 miles of shoreline along the James and York rivers bounds the park. In addition, approximately 24 miles of perennial streams and 30 miles of intermittent streams and drainage's flow through the park. Numerous freshwater tributaries in Yorktown flow through the park. As they approach the James and York rivers, these tributaries become tidally influenced estuarine waters. The Colonial Parkway passes among upland and tidal streams as well as freshwater and brackish ponds. A freshwater spring and a small creek are at Green Spring plantation. In addition, a series of springs and seeps originate on Yorktown Battlefield. Numerous ephemeral ponded sinkholes occur in the Yorktown Battlefield and along the Parkway between Yorktown and College Creek.

Wetlands

Wetlands in the park include forested freshwater communities, emergent freshwater communities and emergent tidal communities. Wetlands cover over 25% of the parklands. Most park wetlands are connected to larger adjacent wetland areas. Park wetlands contribute to species diversity because they support many rare species and serve as nurseries for many different species of fish.

Surface Water Resources

Preliminary findings indicate generally good water quality in most surface waters within the park. However, some streams are impaired based on monitoring for physical attributes and benthos. Most of the water bodies and wetlands in the park have major portions of their drainage basin upstream and outside of park boundaries. Therefore, activities outside of the park can have a detrimental effect on water quality within the park (oil spills, erosion and sedimentation, chemicals).

Floodplains

Approximately 33 percent or 3061 acres of the park are located within the 100-year floodplain.

Erosion and Sedimentation

Erosion is a significant process along the river shorelines of the park. Much of the erosion results from normal and storm induced wave activity yet impacts resulting from recreational use are also a concern. Shoreline recession threatens the cultural resources of Jamestown Island, Glasshouse Point and Yorktown. The park in cooperation with the Virginia Institute of Marine Science and the US Army Corp of Engineers has conducting a study of the 17 miles of park shoreline along the James River. The study has provided a better knowledge of the shoreline erosion process

over the past decades, those areas experiencing the highest erosion rates and recommendations (with alternatives) for conserving the shoreline and its associated cultural and natural resources. A cost benefit analysis has been completed and approved. Major funding has been procured and an EIS is being prepared.

Groundwater Resources

The park, in cooperation with researchers from the Virginia Institute of Marine Science conducted a study to investigate the effects of adjacent urban and agricultural development on the shallow groundwater and selected surface water resources of the park. Testing indicates potential local sources of groundwater contamination from nitrate and ammonia at several sites near Jamestown Island, Williamsburg and Yorktown. Salinity and phosphate concentrations were low or below detectable levels. The US Geological Survey, USGS is conducting a study to develop the hydrogeological framework of the Yorktown area of the park and surrounding environs.

Biological Resources

The biological resources of Colonial NHP include a variety of birds, fish, mammals, aquatic invertebrates, plants and wetlands typical of the mid-Atlantic Coastal Plain. None of these resources is limited to the park, but parklands provide important habitat areas within the larger geographic area. The park contains significant aquatic habitats within the tidal systems found along the shores of the York and James rivers and in most of the tidal creeks to those rivers. In addition, freshwater streams and ponds in the Yorktown unit and along the Colonial Parkway support a number of freshwater aquatic communities. Protection of these aquatic communities is also important because the park provides unique opportunities for public observation, education and recreational fishing. The roadways and access areas throughout the park afford opportunities for close examination of wetlands and waterfowl as well as opportunities for swimming fishing and shellfishing.

Flora

Park records have identified 593 species of vascular flora. Predominant vegetation types within the park includes approximately 5500 acres of forest (including about 730 acres of forested wetlands), approximately 1700 additional acres of emergent (herbaceous) wetlands and over 1100 acres of open fields. Three types of forests grow on parklands. These include the pine, mixed pine and hardwood and hardwood forest types. Loblolly and Virginia pine is the dominant species.

Fauna

As with vegetation Colonial National Historical Park supports a diverse body of wildlife species. The park has recorded the presence of at least 40 mammals, 225 birds, and 81 reptiles (see ***NPFauna***). Common species of mammals in the park include white-tailed deer, silver and red fox, beaver, raccoons, muskrat and turkeys. Small hawk's, owls, Canada geese and other migratory waterfowl frequent the park. Bald eagles and Ospreys have been sighted in several areas. US Fish and Wildlife Service fishery surveys concluded that park aquatic areas serves as an important nursery ground for several important commercial and recreational fishes namely: striped bass, Atlantic croaker, American eel, summer flounder, white perch and spot. Recreational fish observed include largemouth bass, channel catfish, yellow perch, sunfish, American shad, Atlantic menhaden, blue catfish, channel catfish, striped bass, bluegill, black crappie, yellow perch, mummichog, inland silverside, gizzard shad, weakfish, Atlantic croaker and southern flounder. This diverse mixture of fishes is typical for upper estuarine habitat due to the seasonal changes in salinity that occur. Waters in and around the park are known to support oyster beds, crabs, clams, crayfish, perch, sunfish, bluegill and bass.

Rare, Threatened and Endangered (RTE) Species

According to studies by the Virginia Department of Conservation and Recreation, Division of Natural Heritage Colonial NHP has the second highest number of rare threatened and endangered species of all the National Park Service units in the state. The inventory reports indicate the importance of parklands and areas adjacent to the park. The Division of Natural Heritage has recently completed a detailed management plan for these species and habitats.

Species of Special Interest

Colonial NHP is the location of several national champions' specimen trees including Devil's Walking Stick, California privet, Paper mulberry, Compton oak and the Yorktown onion.

Natural Heritage Resources of Colonial NHP		***Number of Occurrences***	
Common Name	***Scientific Name***	***Within Park***	***Adjacent to Park***
PLANTS			
Fibrous Bladderwort	*Utricularia fibrosa*	1	0
Florida Adder's-Mouth	*Malaxis spicata*	1	0
Loesel's Twayblade	*Liparis loeselii*	3	0
Mountain Camellia	*Stewartia ovata*	1	0
Spanish Moss	*Tillandsia usneoides*	0	1
ANIMALS			
Bald Eagle	*Haliaeetus leucocephalus*	2	0
Great Blue Heron	*Ardea herodias*	3	0
Great Egret	*Casmerodius albus*	2	0
Least Bittern	*Ixobrychus exilis*	1	0
Northern Spring sideswimmer	*Gammarus pseudolimnaeus*	1	0
NATURAL COMMUNITIES			
Chinkapin Oak Woodland	Submesotrophic Woodland	1	0
Tidal Brackish Marsh	Mid-Height Herbaceous	0	1
Tidal Freshwater Marsh	Palustrine Wetland	0	1
Southern Mixed Hardwood Forest	Mid-Height Herbaceous Palustrine Wetland Submesotrophic Forest	0	2
	TOTAL	16	5

Invasive Plant Species found in the Park	
Scientific name	***Common name***
Ailanthus altissima	Tree of heaven
Albizia julibrissin	Mimosa
Berberis thunbergii	Barberry
Celastrus orbiculata	Oriental Bittersweet
Cirsium arvense	Canadian thistle
Cirsium vulgare	Bull thistle
Festuca elatior	Tall fescue
Glechoma hederaceae	Gill-over-the-ground
Hedera helix	English ivy
Lespedeza cuneata	Chinese lespedeza
Ligustrum sinense	Privet
Lonicera japonica	Japanese honeysuckle
Microstegium vimineum	Eulalia
Paulownia tomentosa	Princess tree
Phragmites australis	Common reed
Phyllostachys aurea	Bamboo
Pueraria lobata	Kudzu
Rosa multiflora	Multiflora rose
Rulous phoeniculasius	Wineberry
Sorghum halepense	Johnson grass
Stellaria media	Common chickweed
Wisteria sinensis	Chinese wisteria

Monitoring Programs

Current

- Gypsy moth
- Southern Pine Bark Beetle
- E.coli for public drinking waters
- Eagles
- Breeding bird survey

Current Inventory

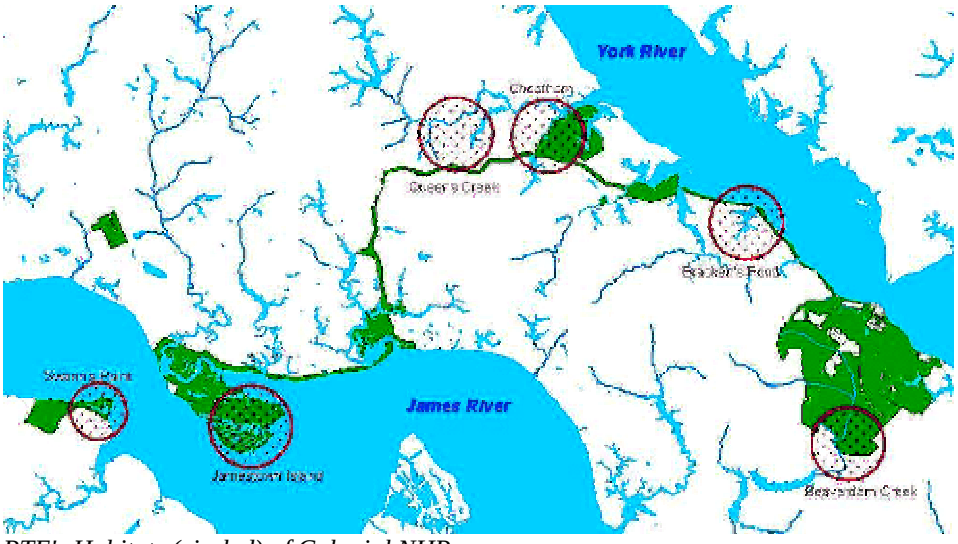
- Sinkholes of Yorktown
- Hydrogeological framework of shallow aquifer of Yorktown
- RTE's of Neck O Land
- Wetlands delineation (detailed) of Neck O Land
- Invasive flora
- LTEM for Superfund cleanup, US Navy, Site 12
- LTEM for NSFO oil leak, US Navy

Completed Inventory

- RTE study parkwide
- RTE study Cheatham
- RTE Wormley Pond
- Groundwater quality parkwide
- Springs and Seeps of Yorktown
- Flora and Fauna of Green Springs Unit
- Shoreline erosion James River section, 17 miles
- Fisheries inventory
- Benthos of freshwater streams
- See attached GIS dataset information

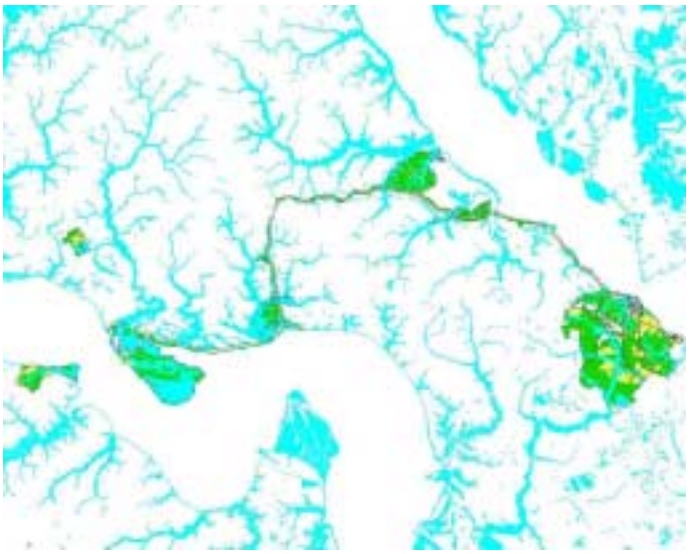
Available Spatial and Aerial Photography Data
The below outlines available spatial datasets and digital aerial photography from Colonial NHP's GIS program. • *The digital photography is in TIFF format. It is generally only available in hardcopies.* • *The GIS spatial data is in Arc View 3.1 shapefile format (UTM18, NA83, meters, GRS80).* • *Most of the park data is registered to the 1:2400 digital aerial photography.*
Aerial photography (prints only): 1:2400 All of the park, natural color, 1 ft resolution 1:1200 Jamestown Island, natural color, 1 ft resolution 1:7200 Jamestown Island, natural color, 1 ft resolution 1:2400 York County, black and white, ½ ft resolution 1:40000, park and region. Infrared color, 3 ft resolution
Boundary - park, regional states, local county and city jurisdictions, NPS areas of the Northeast Region, cities of the Northeast Region. Park data can be delineated by fee vs. less than fee (easements, scenic)
Cultural - earthworks, historic site, archaeological sites, historic vegetation [Jamestown Island, 1606-99 and 1935, 1990] or [Yorktown, 1782, 1940, 1990].
Digital raster graphics - these are digital, georeferenced images of the standard USGS 7.5, 1:24000 topo maps at 400 dpi.
Geodetic Monumenting - USGS benchmarks, GPS order one or near order one, Lat/Lon or UTM or wildlife grid, kilometer markers for parkway and tour roads
Geology, surficial
Groundwater monitoring well sites
Hydrology - river shorelines, streams, ponds, hydrological units, watersheds, sub-basin watersheds, floodplains, springs and seeps, Chesapeake Bay watershed and sub-basins.
Infrastructure – building footprints, utility rights-of-way and types, shoreline structures
Land cover, regional - commercial, residential, mixed use, military, conservation, forest, agricultural
Natural heritage conservation zones
Roads - park (public, Parkway, fire, administrative) local, primary, interstates, VDOT statewide map, road center line, edge of pavement
Soil unit types
Topography - 10 ft parkwide, 2 ft York County and Jamestown Island, 1 ft Jamestown Island, 5 ft James City County
Trails
Vegetation – all, forest, field,, wetlands, sinkholes
Wildfire history

For more information visit the Colonial National Historical Park's website for natural resources at
http://www.nps.gov/colo/NRFINAL/nrhome.htm



RTE's Habitats (circled) of Colonial NHP

Wetlands (green/teal) of Colonial NHP and vicinity



Vegetation of Colonial NHP *Green=forest*
Blue=wetlands
Yellow=fields

Fire Island National Seashore (FIIS) **Fire Island National Seashore (FIIS)** is 19,300 acres of which approximately. 11,000 acres are submerged in the Great South Bay or Atlantic Ocean. This figure does not include Smith Point County Park located at the eastern end within the boundaries of the National Seashore. Terrestrial habitats include 10% forested and 40% wetlands, 25% open (beach, swale and fields) and 25% developed by NPS and 17 local communities on the island. Of the submerged portion, 80% is in Great South Bay and 20% is the Atlantic Ocean. The park also include the William Floyd Estate that is 65% forested, 25% wetlands, 5% open space and 5% developed around the estate house area. Annual visitation exceeds 1 million.

Unique resources include: Sunken Forest (Maritime Holly Forest), Federal Wilderness Area (1300 Acres),and eel grass beds north of the Federal Wilderness Area. Approx. 10 Federal or NYS endangered species breed or germinate in park. Critical management issues include: Endangered species breeding and germination, exotic species management, cultural landscape management, recreational use, resource harvest, deer population management, beach renourishment, in-holding issues, mosquito management and management of commercial interests.

1) List of species of concern.

RTE – Piping Plovers, Least Terns, Common Terns, Roseate Terns, Seabeach Amaranth, Seabeach Knotweed, Northeast Beach Tiger Beetle, Hognose Snake, Spade-foot Toad, Spring Ladies Tresses, Eastern Mud Turtle

Exotics – Bamboo

Habitats of Concern – all are threatened on Fire Island

2) Species/Resources Extracted.

Shellfish harvest (commercial and recreational; subsistence?)
Crab (recreational, possibly. Commercial)
Game fishing (Blue Fish, Stripped Bass)
Waterfowl hunting
Groundfishing (commercial)
Groundwater extraction (wells)
Sand removal (dredging of channels/inlets)
Deer poaching

3) Fully Operational Monitoring Programs

Major T/E and their habitats
(Partial) Estuarine Water Quality. Bayside Erosion, Beach Invertebrates,

Gateway National Recreation Area (GATE) is 26,645 acres of coastal uplands, freshwater ponds, marshes, bays and mudflats. Established in 1972, it is divided into three geographically separate units that constitute some of the largest and most significant natural areas remaining in the metropolitan New York City area. They include Sandy Hook Unit, the Staten Island Unit (Great Kills Park and Miller Field) and the Jamaica Bay/Breezy Point Unit (Riis Park, Fort Tilden, Breezy Point Tip, Floyd Bennett Field, Plumb Beach, north shore of Jamaica Bay and the Jamaica Bay Wildlife Refuge). A tremendous amount of biological information has been produced at GATE through the efforts of park staff and cooperators. Critical issues facing GATE that biological inventory might contribute

knowledge to include: 1. adjacent land uses that impact on aquatic systems(distribution and abundance data would establish a baseline for seagrass). 2. Landscape management at Fort Tilden (abundance data for grassland birds would support reestablishing native grasses), 3. aircraft collision with birds originating in GATE (distribution and abundance data for laughing gull. Cormorant and geese are needed), 4. neotropical migrants use of park habitats and 5. Distribution and abundance measures for park wildlife that have the potential to impact on piping plover (federally listed species) or human health (potential rabies vectors).

George Washington's Birthplace National Monument (GEWA) is located on the Northern Neck of rural and tidal Virginia about 56 kilometers east of Fredericksburg on highway 3 and about 97 km south of Washington, D.C. in Westmoreland Co.. The park is fairly flat, typical of the Coastal Plain, and is comprised of about 230 ha of lands bounded by the Potomac on the north, Bridges Creek and marsh and private lands to the west, Pope's Creek estuary and private land to the south and Pope's Creek to the east. Salinity of Pope's Creek and other marshes within the park can be as much as 60% sea water with crabs, jellyfish, oysters and other marine organisms present. Primary habitats include about 100 hectares of mixed conifer/hardwood forest and loblolly plantations, 90 ha of open fields, 60 ha of fresh and saltwater marshes and swamps, and 7 ha of developed and historic areas. Three freshwater ponds and about 2000 meters of Potomac beach and cliffs are also present.

At GEWA, critical issues include: 1 use of marshes by estuary species; 2 restoration of Pope's Creek as an estuary and spawning area for important species like oysters and sturgeon; 3 relative saltwater and freshwater marsh health; 4 delineating riparian habitats; 5 restoration of forests, marshes, and fields; 6.stabilization of erosive banks along the Potomac and the loss of vegetative species due to undermining of cliffs; 7.exotic species management; 8 restoring cultural landscapes; 9.dune habitat characterization; 10 critical search for T&E species; 11 use or overuse of park resources by species such as deer and groundhogs, 12 effects of pollutants from industry, municipalities, and farming practices on all fluvial and paludal environments; and 13.presenting better information to the public concerning the natural environment at GEWA. Note: Most of Pope's Creek is in Va state jurisdiction, however, a proposal has been submitted to create a National Marine Estuary. GEWA could and should be involved in any restoration efforts.

Exotic Species of Concern include:

Elaeagnus umbellat	Autumn olive
Lespedeza cuneata	Chinese lespedeza
Verbascum phlomoides	Common mullein
Hedera helix	English ivy
Lonicera japonica	Japanese honeysuckle
Rosa multiflora	Multiflora rose
Dactylis glomerata	Orchard grass
Vinca minor	Periwinkle
Phragmites australis	Phragmites
Paulownia tomentosa	Princess tree
Festuca elatior	Tall fescue

Species Watch List - in the area, but not necessarily detected within the park

Lythrum salicaria	Purple Loosetrife
Celastrus orbiculatus	Oriental bittersweet
Polygonum perfoliatum	Mile-a-minute
Pueraria lobata	Kudzu
Sorghum halepense	Johnson grass
Alliaria petiolata	Garlic mustard
Cetaurea maculosa	Spotted knapweed
Cirsium discolor	Canada thistle
Cirsium vulgare	Bull thistle

Carduus nutans Musk thistle

Habitats of Concern

Forests	Aging and little to no succession, need fire as a management tool for restoration. Several plantations need thinning and revegetation with native species.
Grasslands	Dominated by non-native fescues, need of establishment of native species
Wetlands	Inventory and utilization characterizations, health fire needs to be d to restore vigor.
Riparian	Inventory and utilization characterizations, health,and fire needs to be used to restore vigor.
Aquatic	Inventory and utilization characterizations, health,and restoration
Dunes	Species characterizations and assess for T&E presence

Other species of concern: Bald eagle, breeding habitats in mature forests of the GEWA.

Species extracted from the park and habitats affected:

Fish are angled from the park shore.Species: Amberjack, black and red drum, black sea and stripped bass, bluefish, cobia, gray and speckled trout, king and Spanish mackerel, scup, shad, spadefish, summer flounder, taulog, and other freshwater species.
Crabs are taken on state lands on the boundary.
Deer :limited taking on state and private lands on the boundary.
Fowl :limited taking on state and private lands on the boundary.Species: Turkey, mute and tundra swans, snow and Canada goose, mallard and other species of ducks.
Affected habitats: marshes/swamps, estuaries

3. No monitoring programs
4. Additional Management Issues include: **Ecosystem Restoration and Enhancement**. The interaction of entire and intact ecosystems is poorly understood within the Chesapeake basin. There are no "old growth" forests to compare to, no primary predators to control numbers of species in excess of their carrying capacities, estuaries have filled with silt and are loosing the dynamics of a healthy estuary for reproductive success and the yearly return of species, macro and micro fauna such as shellfish populations have dwindled, SAV's are declining throughout their range due to water clarity and quality issues.

Thomas Stone National Historic Site (THST) is located about 32 km south of Washington D.C. The site is comprised of 130 ha of hilly lands that drain into the Hoghole Run, emptying into the Port Tobacco Creek about 1.75km south of the park boundary. Relief of the landscape is approximately 35meters with three main drainages and numerous springs and seeps. About 100 ha are mixed forests, 20ha fields, and 2ha of developed area.

No biological inventories have been done at THST so there is a large gap in knowledge. Critical management issues include: assessing the relative health of riparian and forest ecosystems; planning mitigation for the restoration of fields into native grasslands; planning restoration of forests; determining the presence of T&E and exotic species; determining wildlife use, such as beaver and fish in Hoghole Run; determining effects of hunting and power line rights of way on species, and providing for increased public education about the natural environment around the site.

Exotic Species of Concern

Verbascum phlomoides	Common mullein
Hedera helix	English ivy
Lonicera japonica	Japanese honeysuckle
Rosa multiflora	Multiflora rose
Dactylis glomerata	Orchard grass
Festuca elatior	Tall fescue

Species Watch List - in the area, but not necessarily detected within the park

Celastrus orbiculatus	Oriental bittersweet
Polygonum perfoliatum	Mile-a-minute
Pueraria lobata	Kudzu
Sorghum halepense	Johnson grass
Alliaria petiolata	Garlic mustard
Cetaurea maculosa	Spotted knapweed
Cirsium discolor	Canada thistle
Cirsium vulgare	Bull thistle
Carduus nutans	Musk thistle

Habitats of Concern

Forests	Aging and little to no succession,.
Grasslands	Dominated by non-native fescues, need to establish native species
Riparian	Species and utilization characterizations, health,

Species extracted from the park:
White Tailed Deer, sometimes poached from park, not a species of concern at this time
Affected habitat, riparian - access cutting through to power line right-of-way.

APPENDIX C

Coastal and Barrier Network Monitoring Workshop

Workgroups Reports

Document I	**Water Quality Workgroup Report**
Document II	**Recreation and Visitor Use Workgroup Report**
Document III	**Shoreline Change Workgroup Report**
Document IV	**Species and Habitats of Special Concern Workgroup Report**
Document V	**Resource Extraction Workgroup Report**

Document I

NATIONAL PARK SERVICE COASTAL AND BARRIER NETWORK
VITAL SIGNS WORKSHOP
GATEWAY NATIONAL RECREATION AREA, APRIL 13-14, 2000
WATER QUALITY WORKGROUP

Parks in the Coastal and Barrier Network:

Assateague Island National Seashore
Colonial National Historic Park
Gateway National Recreation Area
Sagamore Hill National Historic Site
Cape Cod National Seashore
Fire Island National Seashore
George Washington Birthplace Nat. Mon.
Thomas Stone National Historic Site

Water Quality Workgroup Members:

Hillary Neckles, Workgroup Facilitator, USGS Patuxent Wildlife Research Center
John Portnoy, Cape Cod National Seashore
Charles Rafkind, Colonial National Historic Park
Scott Gurney, Sagamore Hill National Historic Site
Kirk Havens, Virginia Institute of Marine Science
Norm Rubenstein, US Environmental Protection Agency
Mark Ringenary, Gateway National Recreation Area
Gary Rosenlieb, NPS Water Resources Division
Rijk Morawe, George Washington Birthplace National Monument/Thomas Stone National Historic Site
Brian Sturgis, Assateague Island National Seashore

Water Quality Issues:

The workgroup drew from existing summaries to identify water quality management problems in the Coastal and Barriers Network. The issues listed below were considered the most significant. At a minimum, a vital signs monitoring program should be capable of detecting change in park ecosystems relative to these threats:

Eutrophication, including harmful algal blooms
Contaminants, including toxics, bacterial contamination, marine debris, and sediments
Hydrologic alteration, including tidal restriction, groundwater withdrawal, saltwater intrusion
Acidification

MONITORING QUESTIONS

Discussions of potential water quality indicators were guided by three broad questions:

1. Is water quality changing outside the bounds of natural variability?

2. Does changing water quality impact natural and cultural resources and visitor use?

3. What are the causes of changes in water quality?

SPECIFIC QUESTIONS BY ISSUE

Candidate vital signs were selected to answer the following specific questions related to each management issue.

Eutrophication:

1. Is autotrophic production changing? (water column, benthic algae, and vascular plants)

2. Is community composition/distribution changing?

3. Is ecosystem metabolism changing?

4. Is nutrient load changing?

5. What are the causes of eutrophication?

Contaminants (includes toxics in sediment and water column, bacteria, suspended sediments):

1. Are contaminant concentrations changing?

2. Is light attenuation changing?

3. Are toxic contaminants bioaccumulating?

4. Is contaminant exposure causing acute or chronic responses in aquatic flora and fauna communities?

5. What are the sources of contaminant inputs?

6. What are the physical processes influencing bioavailability of contaminants (including visitors)?

Hydrologic Alterations (includes ground water and surface water withdrawals, benthic alterations)

1. Are water levels changing?

2. Is water chemistry changing?

3. Are community composition, distribution, and production changing?

4. Are species disappearing?

5. Is ecosystem metabolism changing?

Acidification:

1. Is pH changing?

2. Is Acid Neutralizing Capacity changing?

3. What are the effects on ecosystem metabolism (community changes/reproduction)?

4. What are the effects of acidification on terrestrial vegetation and cultural resources?

RECOMMENDED VITAL SIGNS

The workgroup began by identifying as many candidate indicators as possible within each issue category. Potential indicators were considered for their ability to provide answers to the previously identified monitoring questions and in relation to a suite of characteristics of "ideal indicators". All candidate indicators are listed in the Appendix.

Workgroup members then voted on and discussed candidate indicators to select the top priorities for a vital signs monitoring program. The ranking process was guided by the workshop templates (if you could monitor only one or two water quality indicators for the network, what would they be; if you could monitor 3 or 4 indicators what would they be; if you could monitor 5 or more what would they be). The following list includes the top ranked water quality indicators in priority order.

1. Basic Water Quality, to include the following constituents/parameters:

Temperature
Salinity (salt water)/Electrical conductivity (fresh water)
Dissolved Oxygen (to include diel depth profiling as needed to determine the depth and duration of hypoxia/anoxia)
Total Nitrogen, Total Phosphorus
pH
Acid Neutralizing Capacity
Depth

Turbidity/%light transmission
Total water column chlorophyll a
Total Suspended Solids
Fecal-Indicator Bacteria

Applies to estuaries and nearshore environments; freshwater wetlands, ponds, streams

Sampling frequency is monthly or less, with additional event sampling as warranted

2. Land Use/Land Cover/Vegetation Mapping

This indicator includes land use/land cover in watersheds surrounding wetland and aquatic ecosystems, even if watersheds extend beyond Park boundary; also includes distribution of major vegetation types (including submerged aquatic vegetation and potentially macroalgae) within wetland and aquatic ecosystems.

Applies to estuaries and nearshore environments; freshwater wetlands, ponds, streams; uplands; beaches, dunes, spits, shoreline systems

Aerial photographs acquired and interpreted, with ground-truthing, every 2-5 years.

3. Fauna: Species richness, distribution and abundance of macroinvertebrates in saltwater environments
Index of Biotic Integrity in freshwater environments
(Value of fish instead of or in addition to macroinvertebrates should be considered as potential faunal indicator during review)

Applies to estuaries and nearshore environments; freshwater wetlands, ponds, streams

4. Surface and groundwater levels, including:

Hydrography mapping – distribution and connectedness of surface waters, including seasonal and tidal components of surface water cover and depth
Precipitation (quantity)
Consider groundwater chemistry at least annually]

Applies to estuaries and nearshore environments; freshwater wetlands, ponds, streams; uplands; beaches, dunes, spits, shoreline systems

5. Water Column-Sediment toxicity

Potential indicators include bioassays using macroinvertebrates; tissue residues in fish and shellfish, sediment chemistry

Applies to estuaries and nearshore environments; freshwater wetlands, ponds, streams; beaches, dunes, spits, shoreline systems

6. **Amphibian distribution and abundance (**freshwater wetlands, ponds and streams)

APPENDIX

CANDIDATE INDICATORS CONSIDERED DURING RANKING

Eutrophication:

Distribution of submerged aquatic vegetation
Water column total chlorophyll a
Total Nitrogen, Phosphorus, and Dissolved Organic Carbon in water column (also basic water quality: temperature, salinity/conductivity, dissolved oxygen, pH)
Nutrient loads
Spatial and temporal variation of the hypoxic zone
Index of Biotic Integrity
Turbidity
Flushing rates
Land use/Land Cover in watershed
Human population density
Precipitation quality
Wastewater discharges and other point-source discharges
Agricultural runoff
Plant tissue constituents
Benthos/ species distribution and abundance
Denitrification rates

Contaminants (Water and Sediment)

Bioassays
Tissue Residues (fish and shellfish)
Fecal indicator bacteria
Reproductive success-all biota
Species richness and diversity
Benthos
Deployed organisms
Stress indicators
Morphology
Biomass
Density

Sediment Chemistry

Hydrologic Alteration

Surface and Groundwater levels (elevations)
Hydrography
Water Budget
    Ground water/Surface water inflow
    Ground water/ Surface Water outflows
    Precipitation
    Evapotranspiration
Baseline water chemistry (Salinity)
Depth/duration of hypoxic zone
Flushing rate
Acid Balance
Indicator species
    Amphibian types, distribution, and abundance
    Aquatic Invertebrates
    Fish
Sediment

ACIDIFICATION

Acid Neutralizing Capacity
Baseline water and precipitation chemistry
    pH
    NOx
    SO4
    Cl
Amphibians
Dissolved metals
Vegetation mapping/habitat types

Document II

Visitor Use Management Working Group

Group Members: Jeff Marion, Charlie Roman, Beth Johnson, Bruce Lane

Introduction

This working group met on April 13 and 14 at Gateway National Recreation Area along with other working groups at the National Park Service Vital Signs Workshop for the North Atlantic Coastal Park Network. The group members began by reviewing and revising the Issue Statement, listed below. We then developed a matrix of coastal environment recreation activities to indicate what types of recreation are occurring in the four coastal zone ecosystems and at the eight coastal network parks. This matrix was created as background information to ensure a more comprehensive discussion and review of appropriate monitoring questions and vital signs (indicators). Monitoring questions were then developed and presented, followed by the selection of potential vital signs.

Issue Statement (revised)

With annual visitation surpassing twenty million, the five North Atlantic coastal parks are meccas for outdoor recreation. This visitation is leading to increased traffic congestion, visitor crowding and conflicts, and degradation of natural resources. Unmanaged visitation can pose a significant threat to both the quality of park resources and visitor experiences. As visitation continues to rise, protecting park resources and visitor experiences will be a significant management challenge. Monitoring can play a vital role by providing information about the types, amounts, and distribution of visitor activities and their impacts to park natural resources.

Matrix: Coastal Environment Recreational Activities by Ecosystem and Park

RECREATION ACTIVITY	ECOSYSTEMS [1]				NORTHEAST COASTAL PARKS [2]							
	ES	FW	UP	BD	ASIS	CACO	COLO	FIIS	GATE	GEWA	SAHI	THST
Walking/Hiking	X	X	X	X	X	X	X	X	X	X	X	X
Jogging/Running			X	X	X	X	X	X	X	X		
Dog Walking	X	X	X	X	X	X	X	X	X	X		
Fishing	X	X		X	X	X	X	X	X	X		X
Hunting	X	X	X		X	X		X	X			
Poaching	X	X	X				X					X
Swimming	X	X		X	X	X	X	X	X	X		
Bicycling			X		X	X	X	X	X	X	X	
Shellfishing	X				X	X	X	X	X			
NR Collection	X	X	X	X	X	X	X	X	X	X	X	X
Snorking/Diving/ Spearfishing	X	X			X	X		X	X			
Camping			X	X	X			X	X			
Kite Flying			X	X	X	X	X	X	X			
Dune Activities				X	X	X		X	X			
Horseback Riding	X		X	X			X	X		X		
Surfing/Wind Surfing	X	X		X	X	X		X	X			
Nature Observation/ Environmental Ed.	X	X	X	X	X	X	X	X	X	X	X	X
Canoeing/Rowing/ Kayaking	X	X			X	X	X	X	X	X		
Sunbathing	X	X		X	X	X	X	X	X	X	X	
Picnicking		X	X	X	X	X	X	X	X	X	X	X
Boating	X	X		X	X	X	X	X	X			
Personal Watercraft	X			X	X	X	X	X	X			
Driving (On-road)			X	X	X	X	X	X	X	X	X	X
Driving (Off-road)	X		X	X	X	X		X	X			

1 - ES = Estuaries and near shore environments, FW = Freshwater wetlands, ponds and streams, UP = Uplands, forests, grasslands and thickets, BD = Beaches, dunes, spits and shoreline systems

2 - ASIS = Assateague Island National Seashore, CACO = Cape Cod National Seashore, COLO = Colonial National Historical Park, FIIS = Fire Island, GATE = Gateway National Recreation Area, GEWA = George Washington=s

Birthplace National Monument, SAHI = Sagamore Hill National Historic Site, THST = Thomas Stone National Historic Site

Monitoring Questions

I) MONITORING QUESTION: **How are the type, amount, and distribution of visitor uses changing over time?**

Discussion - The group felt that it was very important to document the amount and distribution of the various recreational activities that may be associated with various forms of resource degradation. Such information would be critical to any investigations of response variables, such as wildlife disturbance. However, we recognized that vital signs that need to be assessed for this monitoring question are really Acause@ or Aagent of change@ rather than Aeffect@ indicators. As such, they cannot easily be evaluated with the standard selection criteria applied to other resource response indicators.

Documentation of the types, amounts, and distribution of recreation uses, including new uses and variations of traditional uses, are needed for future comparative evaluations. This is most easily accomplished by convening a meeting of knowledgeable park field staff for all geographic areas of the park. Types of uses can be documented by developing a comprehensive list of recreational activities observed within the park over the past year. Amount of use for each type may be documented by existing visitor use data collection efforts or by rough estimates provided by field staff. It is important to qualify the reliability of various estimation efforts. Distribution of use may also be documented by field staff by mapping locations where each recreational use has been observed. Where possible, rough use estimates (#=s or lo/med/hi categories) may be attached to each area where possible.

Where necessary, such information may be supplemented with data collected at a sampling network of observation points throughout the park. Stratification by general types and amounts of recreational activities and environments is necessary to ensure that date will be representative. Observers would record the amounts of each type of use observed during specified sampling periods. Aerial surveys offer yet another method for obtaining more complete used data for types of uses observable from the air, particularly boats or ORV=s. If aerial surveys are too expensive, ground-based counting may also be considered. For example, boats could be easily counted from NPS patrol boats.

1) VITAL SIGN: **Types of recreation use**
Assessment: a) management workshop to ID and map, b) direct observation from selected sample points, c) park use assessment methods (e.g., entry point question).

2) VITAL SIGN: **Amount of recreation use**
Assessment: a) management workshop to ID and map, b) direct observation from selected sample points, c) park use assessment methods (e.g., entry point counts, parking lot counts), d) aerial surveys for selected use types (e.g., boats, ORV=s)

3) VITAL SIGN: **Distribution of recreation use**

Assessment: a) management workshop to ID and map, b) direct observation from selected sample points, c) park use assessment methods (e.g., entry point counts, parking lot counts), d) aerial surveys for selected use types (e.g., boats, ORV=s)

II) MONITORING QUESTION: **What type and extent of resource degradation is occurring?**

Discussion - Direct assessments of resource conditions are necessary to document specific visitor impacts. A large number of potential resource indicators are possible but only a limited number can be monitored. Some indicators were eliminated from consideration. Funding sources limit this monitoring to natural resource effects so indicators related to evaluating the quality of recreational experiences or the condition of cultural/historic sites and structures were not included. Recreation impacts to air quality were also thought to be minor and difficult to monitor and were not included. Recreation impacts to developed recreation sites and facilities are also not emphasized as facility development and hardening actions are typically emphasized to address these impacts. For example, monitoring erosion on a developed high use trail may be unnecessary if such information is not needed to justify the application of gravel or paving to prevent or limit such impacts. However, some parks may wish to monitor resource conditions at developed visitor use sites.

Emphasis was placed on the selection of a small number of indicators that focus on resource impacts from recreational uses in areas where use in unintended or where facilities have not been provided to concentrate and shield resources from visitor impacts. Emphasis was also placed on visitor impacts to wildlife. Visitor impacts to water quality were also included but are thought to be minor and were rated as low priority by group members.

a) **What are the effects of visitor use on vegetation?**

1) VITAL SIGN: **Vegetation loss**

Assessment: a) aerial photography, direct measurements at recreation sites and along trails where needed

2) VITAL SIGN: **Vegetation compositional change**

Assessment: a) direct measurements at recreation sites and along trails where needed

b) **What are the effects of visitor use on physical resources?**

1) VITAL SIGN: **Unintended trail proliferation**

Assessment: a) aerial photography, on-the-ground surveys

2) VITAL SIGN: **Unintended recreation site proliferation**

Assessment: a) aerial photography, on-the-ground surveys

3) VITAL SIGN: **Substrate erosion**

Assessment: a) trail sampling, recreation site sampling

Discussion - The creation and expansion of visitor-created trails and recreation sites were viewed as some of the most important indicators to measure. This can most efficiently be accomplished by mapping these features from aerial photography, where possible. On-the-ground surveys may be

necessary in areas where tree cover prevents aerial mapping or when additional quantitative information characterizing the condition of trails and recreation sites are also considered important. Disruption of seagrass beds and substrates in areas used for anchoring recreational boats is also an indicator that may be relevant for some parks.

c) **What are the effects of visitor use on wildlife?**

1) VITAL SIGN: **Disturbance time**
Assessment: a) observation along trails and at recreation sites
2) VITAL SIGN: **Road kills**
Assessment: a) road segment sampling
3) VITAL SIGN: **Attraction behavior exhibited by WL**
Assessment: a) observation of visitor WL feeding, b) observation of WL attraction behavior

Discussion - Little or no monitoring of this type has been previously conducted and additional research in needed to select appropriate indicators and assessment protocols. The suggested vital signs indicators are very tentative. Disturbance time refers to an observation of the percentage of time that normal wildlife activities are Ainterrupted@ by the presence of visitors. Stationary observers would record the amount of time that selected wildlife cease normal activities due to the presence of visitors. Actual wildlife responses (e.g., alert behavior, flight) would also be recorded. This indicator was chosen to reflect wildlife disturbance that may lead to temporal or spatial displacement of wildlife from primary to secondary habitats. Monitoring of wildlife killed on selected segments of park roads would provide data on direct injury to wildlife from vehicles. These surveys would need to be conducted with consistent procedures on the same road segments and seasons, with vehicle counters to provide road use data.

d) **What are the effects of visitor use on water resources**?

1) VITAL SIGN: **Water turbidity**
Assessment: a) sampling at recreation sites and paired controls
2) VITAL SIGN: **Biological contamination**
Assessment: a) sampling at recreation sites and paired controls

Discussion - few studies have demonstrated significant impacts to water resources in coastal settings. Possible exceptions include substrate erosion on the shorelines of freshwater ponds, and shoreline disturbance and discharge of human waste from toilets from small boats used to access popular off-shore islands.

Other Indicators Considered

Trail Indicators

Soil Erosion
Cross Sectional Area (sq ft)

Maximum Incision (ft)
Excessive Erosion (# ft/mi, lineal ft, %) e.g., erosion > 1 ft., post-construction
Active Erosion (# ft/mi, lineal ft, %) e.g., segments w/current evidence of erosion
Tread Muddiness
Muddiness (% of tread width)
Excessive Muddiness (# ft/mi, lineal ft, %)
Tread Width
Tread Width (ft)
Excessive Width (# ft/mi, lineal ft, %)
Multiple Treads
Multiple Treads (# at sample points)
Multiple Treads (# ft/mi, lineal ft, %)
Visitor-Created Trails
Informal Trails (#, #/mi, lineal extent, % of formal trail miles)
Vegetative Composition (comparison w/control - change in composition, presence/abundance of invasives)

Recreation Site/Campsite/Picnic Site Indicators

Site Size (sq ft)
Vegetation Loss (%, sq ft) - compared to control
Vegetation Composition Change (Florisitic Dissimilarity, # non-native species)
Soil Exposure (%, sq ft) - compared to control
Damaged Trees (#)
Trees w/Exposed Roots (#)
Tree Stumps (#)
Fire Sites (#)
Human Waste Sites (#)
Litter / Trash (volume)
Shoreline Disturbance (lineal length, ft2)
Composite or Index Values e.g., weighted sum of ratings or standardized measures.
Campsite Density (#, #/unit area)
Illegal Campsites (#, density)
Firewood Gathering Impacts ?
Vegetative Composition (comparison w/control - change in composition, presence/abundance of invasives)

Wildlife Impact Indicators

Wildlife Impacts: Habitat damage, alteration of WL behavior: avoidance, habituation, attraction, direct/indirect impacts to WL

Wildlife Displacement (temporal or spatial)
Area of habitat disturbance

Fragmentation of WL habitat
    Proportion of habitat accessed by visitors (by use level)
    Spatial configuration of human use
Abundance or distribution of sensitive species (comparison w/control)
No. incidents of WL harassment
Disturbance & flight distance by species
No. incidents of nest abandonment
No. incidents of WL feeding
Extent of attraction behavior exhibited by WL
No. incidents of WL obtaining visitor=s food
No. incidents of human injuries by wildlife
Population size (particularly of hunted or fished spp.)
No. animals taken (by fishermen/hunters by spp.)
No. incidents of WL injuries by humans (direct injuries by vehicles, dogs, visitors)
Rare, Threatened, and Endangered Species Indicators
R,T, & E Species Impacts: Habitat disturbance, alteration of behavior, direct injury
Abundance/condition of R,T, & E species (population size, areal extent, no. of locations of occurrence, vigor of population members)

Water Resource Impact Indicators

Water Resource Impacts: Alteration of physical, chemical, biological, or pathological attributes of water resources.
Physical - water turbidity from trail, campsite, or shoreline erosion
Chemical - extent of soaps and petroleum products in water
Biological/Pathological Contamination - extent of contamination by fecal coliform bacteria, giardia, etc.

Document III

Vital Signs of Northeastern Coastal Park Resource Change: Shoreline Monitoring Group Report

Parks: Cape Cod N.S., Fire Island N.S., Sagamore Hill N.H.S., Gateway N.R.A., Assateague Island N.S., Colonial N.H.P., and George Washington Birthplace N.M.

Introduction.

The problem of land loss/gain at the marine edge is basic among the many issues facing coastal park resource stewards in the Northeast Region of the National Park Service (NPS). Shoreline change is a prime geoindicator of coastal environmental resource threats within parks and can be either chronic or episodic, is defined by linear or nonlinear time trends, and displays much spatial variability within NPS units (Allen and LaBash, 1997; Allen *et al.*, 1999). Change in shoreline position drives allogenic replacement of natural habitats (*c.f.* Roman and Nordstrom, 1988) and shoreline retreat will destroy, eventually, cultural resources where they exist. The primary problem facing park management is manifested as coastal erosion, which results from both natural and anthropogenic sources, but coastal accretion can also be problematic for societal use. Semantically coastal erosion is a problem for upland resources because as long as waves and mobile sand exist, so will beaches even though they will move about. Upland resources are not mobile and will be lost. Shoreline change is a basic concern because it also drives change in other items of resource interest to vital signs monitoring within the NPS program: water quality in ground and in estuaries, species and habitats of concern, recreational visitor use, and even resource extraction.

Whereas the general policy of the NPS regarding shoreline change is to promote natural processes, many of the resources in northeastern units were created to commemorate historical resources or to provide public recreational infrastructure fundamental to park operations. Many sites are at risk due to their fixed locations in a zone of changing location. Furthermore, in the long-occupied northeast, the natural landscape has been profoundly altered by human activity. Affects range from topographic remodeling, vegetational replacement, and creation of impervious surfaces. The present land cover is not what it was prior to European colonization and neither have been the natural processes of landform evolution over the past century. External manipulations also provide problems for managing resources with the goal of preserving natural processes.

Amongst the significant natural resource issues of the National Park Service in North Atlantic coastal parks, coastal erosion has been identified as a high priority in a summation of Significant Resource Issues. Cape Cod NS, Fire Island NS, most of Gateway NRA, and Assateague Island NS are located upon the energetic Atlantic shore. However, Sagamore Hill NHS, Colonial NHP, and George Washington Birthplace NM are situated adjacent to more protected estuaries. Nevertheless, they all share the problem of coastal erosion. Even though Acadia NP is excepted geographically from the Northeastern coastal park group, it does contain sand and cobble beaches that are dynamic and heavily utilized by visitors. Southeastern and Gulf Coast park units have similar problems. Much of the resource preservation mandate and contention within NPS units has been focused upon maintaining upland resource stability with little regard to shoreline dynamics because the latter was viewed as

"natural" unless proven otherwise. Recently, however, there has been increased interest in shoreline change because it is directly related to habitat quality for species of concern both at the beach and at adjacent upland sites affected by breakdown of the beach/dune system. The agents of change are numerous and operate at different space and time scales, the stresses of beach and dune change (whether erosion or rapid mobilization) drive complex ecosystem responses in coastal parks that are not well understood. Early identification of changes in past trends, along with some understanding of normal variability, is key to recognition of ecological problems in coastal parks because of the unusually high frequency of topographic disturbance.

All east coastal parks are adversely affected by a relative rise in sea level (roughly 0.2-0.3 m in the last century) at long time scales. Although slow, this is a chronic driving force. Substantial shoreline retreat is also driven by aperiodic storms (tropical hurricanes in summer and mid-latitude nor'easters in the winter). Storm effects upon the beach shoreline may be ameliorated within a week or two but if the dune system is degraded, a
decade of storm quiescence may be needed for dunal recovery. Spatial variability dominates most trends of shoreline change (e.g. Fig. 1) over both long and short time scales but there are local amplifications with temporal persistence of change due to offshore controls upon wave forcing or antecedent conditions of morphology. If human manipulation is absent (which is not the case prior to NPS management of the barrier parks), dune change trends contain less temporal variability and thus approximate the longer term trend of the coast than the shoreline per se (Psuty and Allen, 1993) but when the dune is breached and the local area shifts to an overwash regime, the ecological change is dramatic. Bluff or upland bank sediments are relics of depositional process long gone in the estuarine parks and with no natural process of sediment recovery now, erosion of this morphology is permanent.

Despite these pervasive and natural causes, with much spatial and temporal variability, many cases of coastal erosion in the northeastern NPS units are locally accelerated and caused by human perturbations to the natural system of littoral sediment sources and sinks. Specific changes to tides, waves, currents, and availability of sediment have profound morphological and ecosystem feedback. Examples range from stabilized inlets for navigational benefits (ASIS and FIIS), seawalls and groins (GATE), to stabilized shorelines for inland protection, and even beach and dune rebuilding with added sand from an external source. All of these actions have been intended for the general benefit of some in the densely populated northeast but these projects also restrict natural processes. The lag time for natural equilibration is unknown in each case and their duration of impact is often confounded by continued needs for maintenance of the existing projects. Habitat and ecosystem responses to such changes are not well

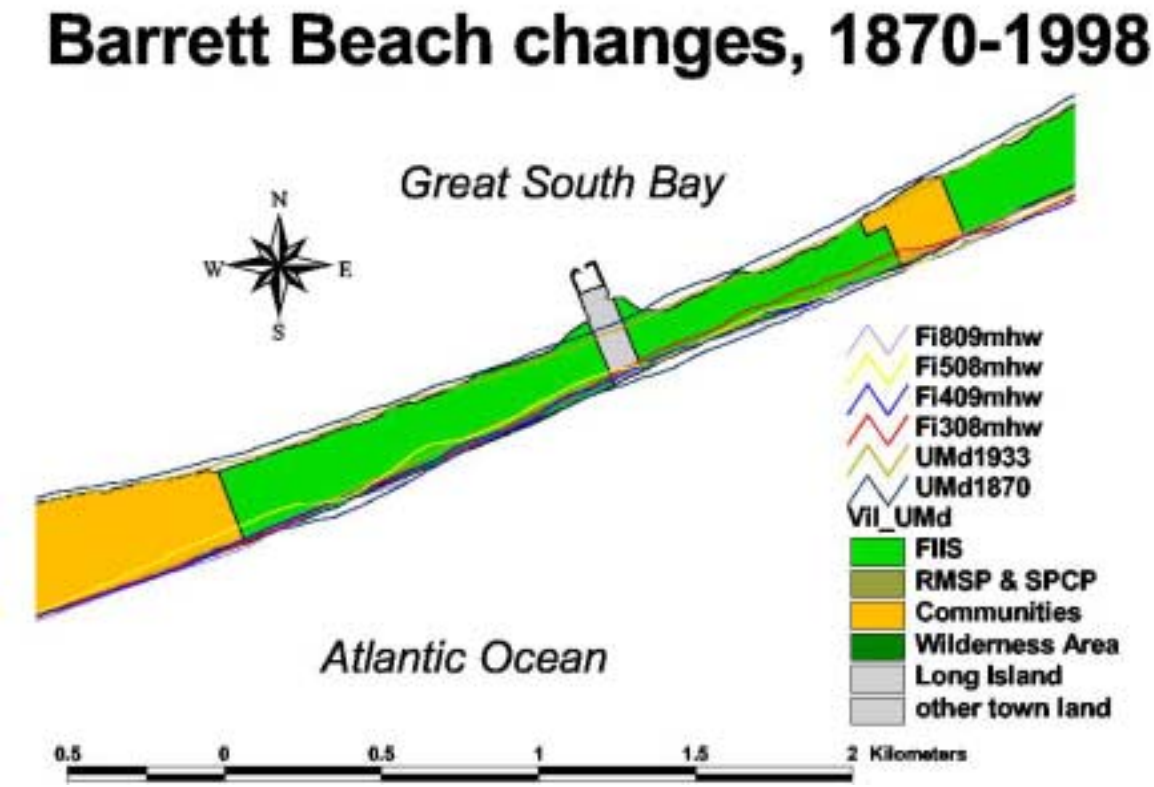


Figure 1. Fire Island NS example of shoreline change over a century but with an emphasis upon recent spatial variability. The narrowest portion of the island NS is becoming thinner and there are large, migrating shoreline undulations, which continue to erode the oceanside dune complex. Bayside erosion is also present but the present plan to remove the marina includes transfer of the sediment to increase the height of the low areas to mitigate increased threats of island breaching and promote natural sediment transport instead of the blocking effect of the marina structure.

understood by ecologists, let alone by the responsible stewards. How far and for how long these impacts persist are basic problems unresolved at the local level.

For managers, an understanding of the spatial and temporal patterns of shoreline change is basic to optimal management of any coastal park because: 1) the interface of marine and land systems is very dynamic and is driven by multiple forcing mechanisms, 2) it results in alterations to resource patterns and dynamics at habitat and ecosystem conditions, and 3) it will eventually result in the loss of static cultural resources. Preservation and protection is mandated for resources, which are threatened and considered of national significance, even though this does not require *in situ* retention.

Summary of group discussion.

The northeastern U.S. coastal parks "Vital Signs Workshop" included a shoreline change component composed of governmental and academic coastal "experts". Collectively, we agreed that one of the fundamental problems facing resource managers in coastal locations is the spatial patterns of loss or gain of land due to shoreline change. Furthermore, these lands contain resources deemed important by

many, including the U.S. Congress (we had a slight disagreement as to whether this measure or water quality was the most important). We believe also that the best means to understand the process of change, and identify likely causes of problems, is through viewing the sediment budget within the park and within its regional context. Although quantifying the amount of sediment advection is difficult, volumetric imbalances can be identified in sediment source/sink relationships with a reasonable effort at various space and time scales. The current technology of Geographic Information Systems (GIS) is readily applicable to solving some of the problems, presentation to managers, and the task of understanding spatial process linkages.

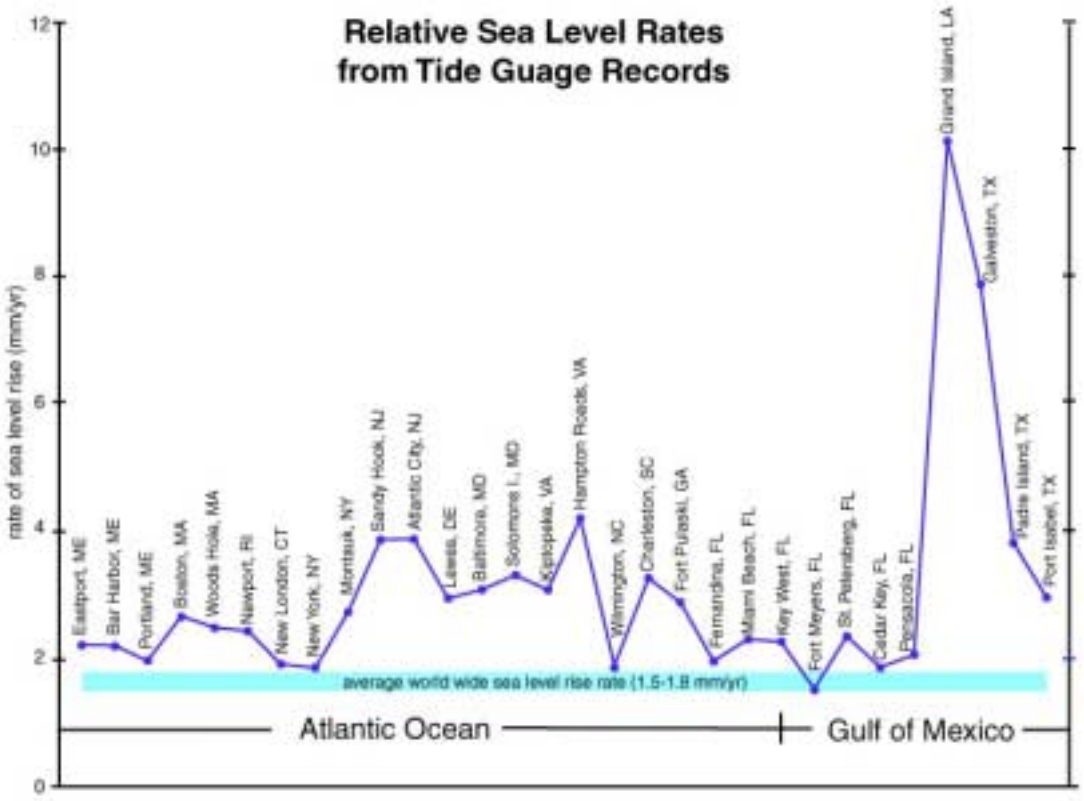
A jargon-rich but key summary statement was that NPS managers need to understand, at each park level, "what is the spatial and temporal variation of the frequencies and magnitudes of coastal change?" affecting key resources and the overall integrity of the park. Such understanding would identify chronic vs. extreme events, natural vs. human origins, identify local vs. regional patterns of effects and allow for some aspect of predictability of future problems. The ability to put any storm-driven change into an understood pattern of variability would be very useful to park management. The linkage of shoreline change to other ecosystem resources is critical in definition and application of strategies for their protection if needed, and forecasting of natural evolution.

We used incident wave energy to separate shoreline dynamics of northeastern U.S. coastal parks into two groups: **1)** *open ocean shores* with high wave energy, mobile (usually sand-sized) sediments, and large length scales of sediment transport (Cape Cod NS is the only exception to the external boundary sources and sinks characterizing the other barrier island parks), and **2)** *fetch-limited shores* in estuarine locales which are defined by very small space scales for sediment transport (*e.g.* Nordstrom et al., 1993) and management options are different (Hardaway and Byrne, 1999). Barrier islands and Cape Cod contain both which can lead to narrowing and eventually to in-place drowning. Each of these two classes also possesses different morphology and vegetation, which restrict logistically and technologically the choice and accuracy of available methodologies for assessing shoreline change trends. Despite the energetic differences, both shoreline types can have high rates of shoreline change.

Results.

The shoreline change group agreed that understanding this problem requires an adequate measurement of the hydrodynamic forcing of sediment transport, morphologic change, and ecosystem response at the level of the individual park unit. These are very complex tasks, which are way beyond the capability of the National Park Service to perform. However, there are other agencies (federal, state, and local) which have long term monitoring mandates that provide some of the information needed, if not perfect, for individual parks. In NOAA, the National Ocean Service has pertinent oceanographic data available on websites for access: predicted tides http://www.opsd.nos.noaa.gov/tides, both predicted and observed water levels at http://co-ops.nos.noaa.gov/data_res also give plots of storm surge, and the National Weather Service operates the National Data Buoy Center and its array ringing the US. At http://www.ndbc.noaa.gov/Maps choose an appropriate region then station and download near-real time or past data on wave heights and periods, sea and air temperatures, atmospheric pressure and wind. Some process information gaps can also be filled by temporary data acquisition projects, such as those with the US Army Corps of Engineers coastal programs (*e.g.* Stauble, 1994) which, conversely, are often viewed as a potential threat to park resource management strategies. Local

identification of the rate of relative sea level rise (RSL), tide range, storm surge frequency/magnitude, wave heights, and sediment transport volumes and directions are required to understand just what is causing shoreline changes; such detailed data is unlikely. Thus regional trends in driving forces must be extrapolated or subjectively interpreted from such data sources as above. Fig. 2 shows the large regional variability in relative sea level rise along the eastern seaboard due to regional subsidence, local subsidence from fluid withdrawal, and local compaction of barrier islands. These rates are closely linked at the local scale to changes in the hydro-regime of salt marshes and available sediment budgets for such habitats to persist. Salt marshes cannot exist without sufficient vertical accumulation to offset RSL and are thus are dependent upon adequate sediment supply (which is problematic in estuaries of dammed rivers or controlled inlets) or actual rates, which may accelerate in the next century beyond that measured in the past one). Other problems such as disease, rodent eat-outs, and human destruction



also lead to

Figure 2. Variability in relative sea level rise as measured at NOAA tide gages along the East Coast of the US. Note that few gages are actually located inside or adjacent to a park so some extrapolation is necessary to understand the context; be warned that steep local changes may not result in proper values from the linear trends suggested between gages.

a loss of salt marsh acreage beyond the natural losses. Most geologic studies indicate little salt marsh habitat prior to the flattening of sea level rise and the few exceptions seem to be related to island overwash or breaching, with subsequent inlet migration or island drowning, leaving behind very shallow waters wherein Spartina could become established for a time. Large-scale processes such as

barrier breaching and overwash regimes must be clearly linked with estuarine circulation patterns and ecosystem requirements.

At the park level, we identified three basic elements of shoreline change that are reasonably easy to measure, are easily replicated, and thus provide for time series analysis with adequate accuracy and precision, in order to understand the space/time pattern. In priority order, these variables are: ***1)*** *estimation of the oceanic shoreline position and its trends and variability,* ***2)*** *a measure of the more inland interface of the upland edge vs. wave domination, and* ***3)*** *elevational change data characteristic of the coastal topographic envelope of concern.* The latter, combined with items 1 and 2, provides dimensional data on imbalances of (sediment) mass budgets at specific scales. We did not address the more problematic areas of low relief, saltmarsh survival in fetch-limited areas, as discussed in Roman, *et al.,* (1997) because of the lack of information on a park-by-park basis.

Although shoreline position has been carefully mapped in the U.S. since the 19th century by present standards, existing data are sparsely defined in temporal space thus the historical data do not necessarily indicate trends over shorter periods such as decadal or annual change. Just what defines the "shoreline" is also poorly defined in the historical survey literature although the goal was to measure some aspect of Mean High Water and used wet/dry contacts or wave runup markings such as wrack lines where present (see Shalowitz, 1964). The landward margin of wave influence, by definition, is a more conservative indicator of long-term trends than the day-to-day shoreline because it is less involved with small magnitude events ranging from individual wave runup, through tidal inequalities, to storms of various intensities. The toe of the either the bluff/bank or foredune/vegetation line would be the proper inland parameter to survey and is visually more distinct than the wet/dry transition estimation, although not without its own interpretive problems. Only an ATV should be used in such surveys so as to minimize ecological impacts of the passage. Pedestrian traverses are simply inefficient in time and space for large-scale mapping. Changes in land/water interfaces have directionality (loss or gain) and are quantifiable in space and time, resulting in both identification of trends and variability. The appropriate space and time scales of change are key to both scientific understanding and management success of park units. Furthermore, each variable has been measured in the past for a long historical record to place short-term measurements into a better context of variability. Justifications and caveats for each are provided below, along with assessments of available technologies for measuring them (obviously, technologies evolve but to keep the measurements relevant some objective measurement detail must be relevant throughout the data-gathering process). The more energetic and dynamic shoreline change data is of less value in exposing long term trends of coastal mobility because of its high variability compared to a measure of the inland limit of storm wave influence, say a vegetation line for interannual variability or the upland boundary of scarp-involved migration under erosional conditions.

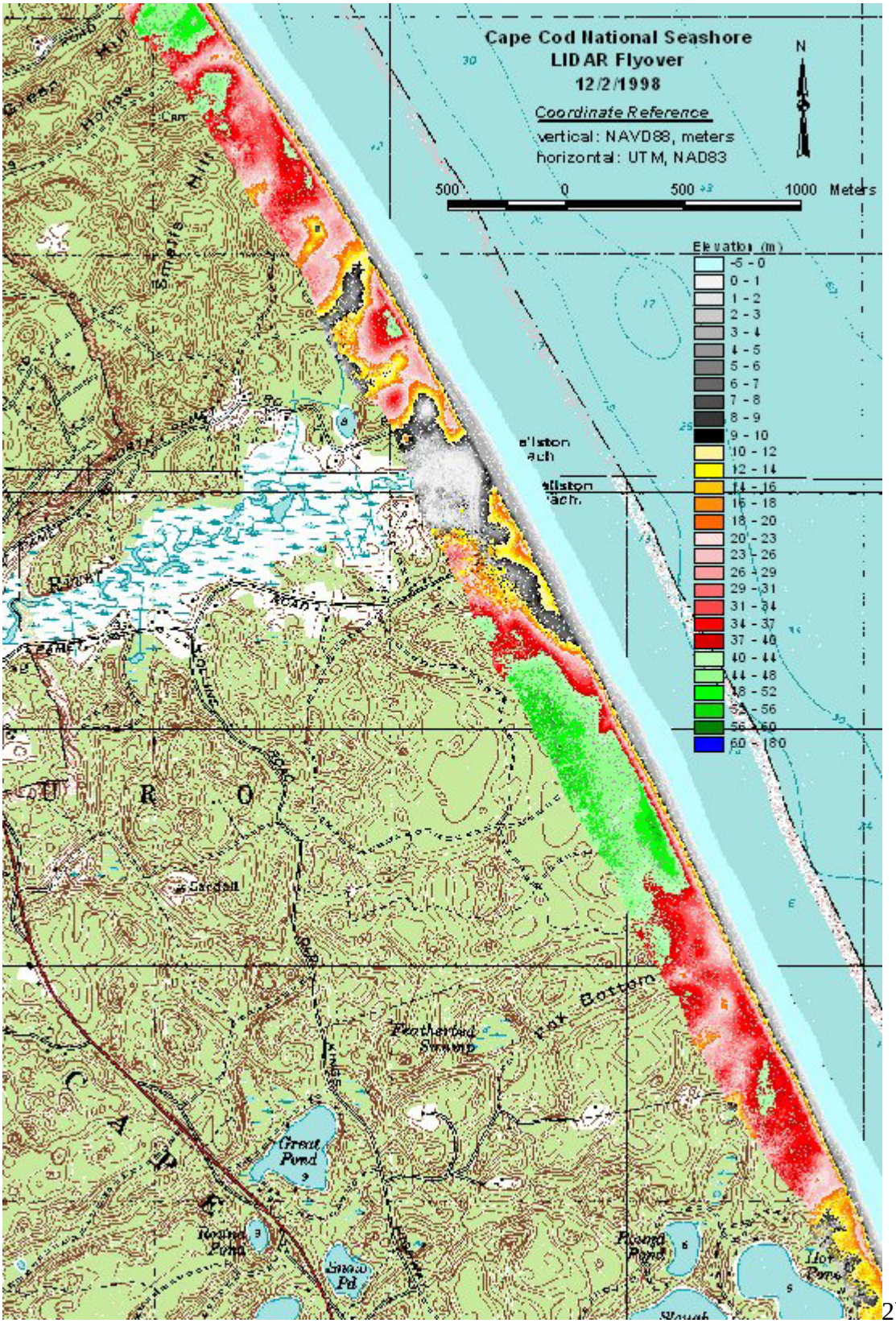
Methods.

The National Park Service has opportunistically benefited from committed individuals at the cutting edge of how to measure shoreline change in its parks at the research level but has not transferred this capability down to its field staff. This is a programmatic and staffing deficiency that must be addressed at the national level in many regards. The lack of an internal research capability is especially constraining to resource managers. Moore (2000) presents a review of shoreline mapping

techniques but analytical tools are incomplete, let alone a method for communicating results to park managers.

1) *Airborne topographic mapping* (ATM, also termed Lidar because of the laser-based technology) is capable of very large spatial surveys (hundreds of km^2 in a few hours) and will becoming the technology of choice for at least the next decade to measure physical elevations and monitor change. ATM restrictions are limited largely (now) to a decimeter elevational accuracy for bare sand (see Krabill, et al., 1999) with as yet unresolved vegetational biases. Presently there are data managerial problems of matrix size and GIS acceptance, and spatial resolution (and replicability) of x,y,z measurements plus integration into the NPS standard of GIS data management. Although clear depiction of morphology is possible with 5x5 m pixels (Fig. 3) and crude comparisons can be made, change analysis often requires spatial clarity at 1x1 m resolution. Formidable computational requirements exist. A method for mapping an estimate of the shoreline does not exist yet. These are viewed as temporary constraints upon an extraordinary technological development and, although not fully operational, research efforts have overcome most of the limitations at site- and problem-specific levels. A national hazards evaluation program is needed for east coast parks but a few already have inventory and annual monitoring data available (ASIS n>6, FIIS n=3, CACO n=2, GATE n=1). Individual event (major storm) occurrence monitoring and seasonal variability is needed (and has been done in a research venue by J. List/USGS Woods Hole in conjunction with the CACO ATM surveys) but no regional support program exists. Scientific analysis of the change data is required to fully utilize this new and essential tool for monitoring the large-scale, topographic "vital signs" for the barrier parks, emulating Sallenger, et al. (1999) who managed to obtain signatures of shoreline response to the 1998 El Nino on the California coast. Allen, et al. (in prep. and poster, ESRI Users Group 2000) extended the analysis of ATM data to compare selected upland/beach profiles obtained over more than a century and have developed methods for spatial comparisons in the NPS standard of ArcInfo/ArcView.

2) *Aerial imagery* (and its orthophotographic derivatives) offers much more information than topography. Photography and videography can provide images suitable for shoreline depiction if rectified. However, much of the information is subjective and geospatially limited by scale distortions. Vertical accuracy is unverifiable and probably not to even a meter in developing contour maps. Nevertheless, many A&E firms have the capability of providing topographic maps from aerial surveys, which even with the low topographic relief of most coastal parks in the northeast, can be useful. Also,



most 2) Figure 3.

ATM data interpreted in ArcInfo for Ballston Beach area of Cape Cod bluff and overwash sections of extreme and subtle relief. Note how well the ATM fits the topo map.

historical shorelines in the 20th century were mapped from the dry/wet (as indicated by the white/gray or similar tonal change on color imagery) so historical baseline exists for a time series expansion based on this measure. Fetch-limited shores have very low relief and their land/water contacts are not easily interpreted from this type of measurement, plus they tend to be heavily wooded and not conducive to Lidar imagery. GPS-controlled videography may be the best bet for a good method. Despite recent improvements, historical satellite imagery, such as LandSat, is too coarsely defined in spatially in pixel size for park-scale use. Aerial imagery is estimated to be of quantitative value at only 5-year intervals due to resolution problems. There is no existing regional program to achieve these needs. The strength of the ATM approach is its great spatial coverage and relative accuracy.

3) *2-D or 3-D Field surveys.* These are more local and with much greater accuracy in resolving elevational or positional change, down to mm. The design can be either of transect or grid designs but requires much in the way of staff, time, and benchmarks for geospatial relevance. Depending on programmatic needs, transect intervals of 1 km have been sugggested but the USA COE will use denser intervals in beach nourishment projects. Very long and large data set analyses have been reported by Wijnberg and Terwindt (1995) and Lacey and Peck (1999) but require special statistical analysis due to the large matrices of profile changes. Localized problems, such as monitoring dune blowouts, trail degradation, vegetation/topographic dynamics require detailed, site specific monitoring well beyond the capability of ATM in the foreseeable future. Some parks have existing programs, usually with cooperating university-based scientists or federal researchers, but again there is rarely a programmatic base other than in natural resource management divisions, which occurs in only a few parks with ASIS and CACO being the leaders.

GPS mapping of the Mean High Water line, subjectively interpreted as the same wet/dry line in historical measurements is supported by historical extenuation of time trends but is difficult to replicate because of its visual interpretation. This method is further limited in accuracy by the type of instrument chosen, although mapping grade units can be differentially corrected down to only a meter or two on the open coast. Total error for comparison of two different surveys could exceed 5m if different drivers are used without careful training and there will always be some subjective differences in choice of the driving track. ArcInfo-based GIS analysis has been developed (Allen and LaBash, 1997) for NPS at a 50-m interval (Fig. 4) and this spacing has been suggested to be most efficient in computational time and spatial resolution. This means parks can run their own programs or in can be done at the regional level with results communicated directly to parks for their in a compatible format. A phased time-sampling period is suggested to incorporate frequent events with different return intervals into a longer-term matrix of change. Once event-scale perturbations are quantified, seasonal to interannual comparisons can be made within this estimate of error. A high priority is to build the historical survey data of the 19th and 20th century into the data base to add a more robust time dimension but also to provide change data under different physical scenarios (inlet/no inlet, migrating inlet) and human involvement (jetties, seawalls, groins, beach nourishment).

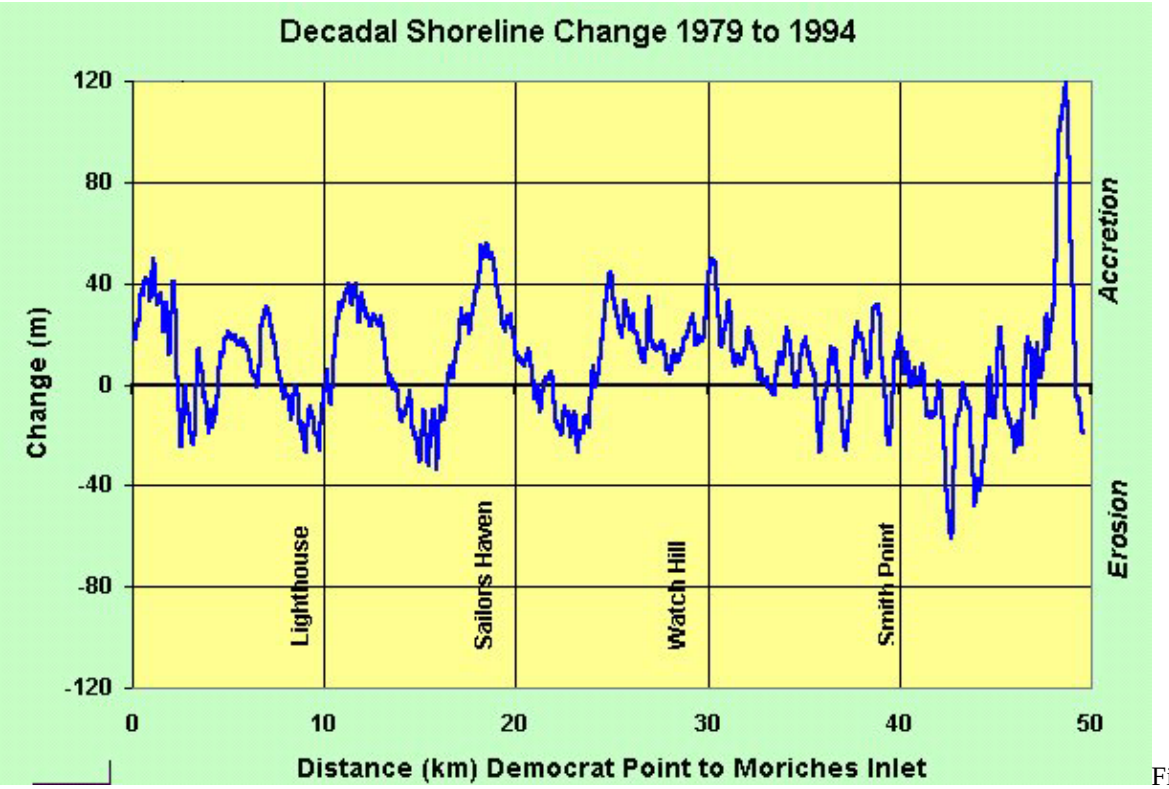


Figure 4. End-point shoreline change along Fire Island NS between 1979 and 1994. More data are available in the period but this was chosen to display a decadal scale response to the series of storms in the early 1990s everywhere along the island. The west is dominated by alternating waves of erosion and accretion with a 6 km spacing, the east contains a trend of erosion which is greater towards Moriches Inlet but with high frequency variability and a major peak suggesting that natural sediment bypassing of the inlet (jettied by 1953) had finally developed in the interim.

The USGS SWASH vehicle (List and Farris, 1999 and *http://chumley.er.usgs.gov/swash*) is now the most accurate and complete system available for measuring shorelines on open beaches at large spatial scales (tens of km) and attempts to limit the error to within a meter or two. However, it has major problems of cost, deployment, and maintenance in a monitoring mode in multiple parks, beyond the linear foreshore slope assumption used in calculating a MHW intercept. Thus it would appear to be more suitable in a research mode, to accurately define event-scale changes in the various parks on an annual rotation basis to another park, instead of use in a long-term monitoring program region-wide. For monitoring purposes, available equipment and staff in parks should be used for efficiency of data acquisition. Technical experts must do the analysis, however, and they will have to help in the training of park staff. Again, few parks have developed expertise in GIS analysis although this is improving—ASIS, CACO, and COLO are exemplary.

Elevational change data are required at local scales to complete the volumetric estimation of sediment imbalances. These require and can provide less vertical error than with the ATM survey. Such data require the deployment of a field surveyor and one or more people with surveying rods/prisms to record vertical differences. In principle, these should be cross-island and extend offshore to depths exceeding 30 m to incorporate the accuracy of limits technology in detecting observed changes in

topography, hence sediment exchange. In most parks this is impossible unless another agency is willing to commit its resources to such a purpose. Sometimes, local universities can commit staff and students to such an effort but long-term monitoring of change patterns is not guaranteed. Neither are client serving relationships within DOI unless self-motivated for long-term programs of research. Intensive monitoring of problem sites and general monitoring of cross-shore transects to include subaqueous topography is required to understand the envelope of change and provide warning about whether change will be adverse.

Additionally, in low energy sites, erosional pins (also known as depth of disturbance rods if a washer is attached) can be deployed for event-scale surface change measurements at mm scale precision. These devices possess excellent spatially stability of sampling but do not withstand disturbance by ice movement or human curiosity for long. Pin-based survey systems must be tied together by another elevation-controlled technology and, while excellent for local elevational change measurement, are short-lived in temporal survival. Because tidal amplitudes are usually greatly diminished in low energy environs, we believe that the radical change in foreshore to nearshore slope at the base of the beach (e.g. Jackson *et al.*, 1993) seems to be the most replicable, single feature for measuring horizontal excursion from a benchmark. This bayside attribute is equivocal to the bluff/bank top of a scarp in an upland park area as a fundamental target, where present.

Site-controlled photodocumentation.
Although everyone agreed that hand-held camera records are a valued tool when added to more quantitative techniques, the method contributes little beyond visual display to depiction of perceived change. Observed differences could be either short-lived or permanent but the image comparisons revealed no time constraint on the process or the response. A local, time-restrained, subjective interpretation is generated but not accurate, quantitative monitoring data is the normal result unless scaled indicators are in the field of view and lens data are available, along with precise view point orientation for scaling.

A major difference occurs if remotely deployed, digital video monitoring is utilized but this is considered to be only a research tool at present because of the rigorous demands for initial installation and surveying of control points, system maintenance, and post-processing analysis of the data. With time, video imagery can become more user-friendly and thus more efficient in monitoring both hydrodynamic processes and analogues of bathymetric change. Now, however, it is limited to visual documentation of land cover in a monitoring mode. More positively, it does provide useful evidence, which can be manually interpreted and entered into GIS data layers for other management analyses.

Quantitatively, the analysis problems within photodocumentation are now major because there is no generic software and the technical skills required are at research levels instead of being commonplace. Hopefully, technological and educational development will improve this view but politics may rule over reason yet again.. Visual documentation is viewed positively for many subjective aspects of use, especially for carefully gathered long-term documentation, but has severe limits upon its quantitative application at the present. Most parks have historical photography records and many have a loose definition of photodocumentation policies but there is no systematic monitoring or assessment program in NE coastal parks that we are aware of.

Design and Implementation.
These preceding methods are available at all space and time scales deemed necessary and are affordable. Many coastal park staff members within the NPS are already well aware of the opportunities, needs, and available methods because of the close communication between field and research personnel in the Northeast. However, intra-regional duplication of effort to train staff and purchase equipment is not viewed well to solve the park-by-park problems.

Within the present organizational structure of the Northeast Region of the NPS, we think a single NPS-based employee could *lead* the monitoring efforts required in the coastal parks, with adequate skills and training for data acquisition and analytical processing. Such a staff member could be stationed regionally, with a requirement to support all coastal parks when and where needed. A university-based appointment for this person would most efficiently use new advances in technology and methodology, provide access to highly skilled analytical interpretation, and may be in the best interest of the Northeast Region of the NPS. Individual park staff would be needed still to supplement the field survey requirements at the local level, instead of student help. GIS-based analysis of shoreline changes and ecosystem threats, as well as a communication format, should be made a high priority for the NE regional program and would also be facilitated at a university location (or at a park where the competence exists).

Given the great value of resources at risk, we also recommend that the title of the component be renamed "shore-zone" change because it is the combination of nearshore, beach, and dune/upland process-responses that are associated through shoreline changes to subaerial and submarine resource impacts. Shoreline change is a concept that has become a legal issue of indefinite definition, given the highly dynamic nature of MHW shorelines and yet remains, over longer time intervals, in the more conservative boundary of inland wave dominance in various space and time scales. It can be argued well that the inland margin of wave dominance is the better scalar of barrier and habitat dynamics but even an approximation of the MHW line will yield better information on the short and long-term rates of change, hence habitat and resource threats because the MHW line has less error in interpretation and definition without severe ecological problems.

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Document IV
Workgroup - Species and Habitats of Special Concern

NPS Inventory and Monitoring Program
Vital Signs Workshop, Northeast Region
Coastal and Barrier Island Network

Parks in the Coastal and Barrier Network:

Assateague Island National Seashore	Cape Cod National Seashore
Colonial National Historic Park	Fire Island National Seashore
Gateway National Recreation Area	George Washington Birthplace Nat. Mon.
Sagamore Hill National Historic Site	Thomas Stone National Historic Site

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Introduction:
A workshop was held on April 13th and 14th, 2000 at Gateway National Recreation Headquarter on Staten Island, NY to assist NPS managers in developing a vital sign monitoring program for NPS northeast coastal parks (Coastal and Barrier Island Network). The following products were requested by each workgroup as a function of this workshop:

- a list of significant tissues influencing the ecosystems
- a list of issue related monitoring questions which a monitoring program could be designed to answer
- a list of vital signs that address the identified monitoring questions
- Prioritization of vital signs

Based on pre-workshop work conducted by the NPS I&M monitoring coordinator in conjunction with individual parks, a description of significant resource issues faced by NPS units in the subject network, several focus groups were determined from which detailed information on vital signs would be developed. One workgroup focused on species and habitats of special concern: specifically dealing with non-native and invasive species, rare, threatened and endangered species, and habitats and communities of special significance. Based on the discussions and interactions within this workgroup, the following results were tabulated:

I. Significant Management Issues Influencing the Coastal System:

Vegetation change
External threats
Native biodiversity
Controlling exotics and invasives
Endangered species//Biology and habitat
Water quality
Feature species – historic
Health and condition populations

II. Monitoring Questions

What is the changing trend of exotic species (frequency, abundance, and distribution?

What are factors contributing to exotic species?

What are effects of exotics/invasives on Park resources?

What is the changing trend of rare species (frequency, abundance, and distribution?

Changes in species [diversity] composition of major habitats

Changes in spatial distribution and abundance of major vegetation communities (mapping) i.e., communities of concern

What are the changing trends in featured species?

Adjacent land use - rate of change

III & IV. Vital signs and associated components:

ID of vital signs –species/habitats
1 – quantitative
2 – easily measured
3 - sensitive to stress

Changing spatial distribution /abundance of major vegetation communities
and map spatial distribution of habitat
*****Mapping intervals
*****Permanent plots establish and revisit (groundthuth
*Abundance of epiphytic algae in eelgrass beds

Featured species (e.g., deer, ponies)
*Demographics
*Population parameters

Adjacent land use, rate of change (watershed scale)
*%forest cover
*Density of homes
*Miles of road
*Land use classification

Trend of Exotics
- *Frequency
- *Abundance
- *Distribution

Threatened and endangered Species
- *Distribution
- *Abundance
- *Habitat
- *Recovery Plan Goals (metrics)

Changes in species composition & diversity in major habitats
- *Vegetation (N, H', Dominance, Structure)
- *Native freshwater fish
- *Amphibians - population turnover, reproductive success/richness
- *Migratory birds diversity /predation/ nesting trends
- *Small mammals - abundance/trends
- *Changes in original composition of Park resources (from some predetermined time) (% of Parks original biota still extant)

External threats
- *Bioaccumulation of chemicals
- *Human Health
- *Human Economics
- *Miles of road
- *Density of housing
- *Community Classification

Document V
Resource Extraction Working Group

Group Members: Dave Avrin, Tonnie Maniero, Carl Zimmerman, Jim Ebert, Bill Jackson, Dave Franz, Gary Brewer

Introduction

The group members began by listing all potential resource extraction issues/threats that could exist within the identified network parks utilizing the group's knowledge and the profiles submitted by each park. We utilized this list to prepare a "Stressor/Response Table" (See "Resource Extraction Issues Identified" below). As we generated the list it became apparent that most of the issues in this particular Work Group would probably be duplicated in other groups.

Resource Extraction Issues Identified

1. Finfishing (all parks)
2. Shellfishing (all parks)
3. Groundwater Extraction for Potable Water and Irrigation (CACO)
4. Sand Mining (ASIS)
5. Channel Dredging (GATE)
6. Hunting (most parks)
7. Recreational Collecting - mushrooms, shells, butterflies, herps, etc. (not identified as a major issue in any of the Network parks)
8. Surface water extraction (COLO)

Threat	Stressor	Response
Shellfish Extraction (commercial and recreational)	Bottom disturbance	Decline in biodiversity Degraded water quality Recreation impact
Finfish Extraction	Loss of predation	Decline in biodiversity Degraded water quality Recreational impact
Hunting/Collecting	Decline in species #'s (mushrooms, butterflies, deer, plants)	Impact on decomposition Impact on pollination Decline in biodiversity
Groundwater Extraction	Change in water table Nutrient loading Increased salinity in groundwater	Increased salinity Change in plant/animal species Increased contaminant delivery to system
Sand Extraction	Change in littoral drift Change in shoreline dynamics	Change in shoreline (beach retreat) Change in shoreline bathemetry
Muck Extraction (Dredging)	Resuspension of contaminated sediment. Change in hydrography and sediment	Erosion Contaminant redistribution Change in light penetration Change in benthic diversity

	suspension budget	

Brainstorming Monitoring Questions

Finfishing, shellfishing, collecting and hunting (combined**)**

1. What species are being harvested/hunted and at what level?

2. What is the level of effort being expended (catch/unit effort)?

3. What is the relationship between the park population (ie regional fishery) and the regional population (ie fishery stock)?

4. What resource is within the park's control and what is not?

5. What are the secondary effects of harvesting/hunting techniques (bicatch, other species, anadromous fish, outboard engine pollution, etc.)

6. Does harvesting/hunting result in any physical disruptions to habitat?

7. What is the appropriate/acceptable level of harvest and how is this best determined?

Groundwater Extraction

1. What are the effects on water tables (very significant), uplands, estruaries, wetlands and surface water availability?

2. What are the effects on groundwater (saltwater intrusion, contaminant loading)?

3. What are the direct and indirect impacts on biological systems (plant species composition, wetland dependent plants and animals, etc.)

4. What is the temporal nature of extraction in relationship to natural variation that occurs within the system?

Sand mining/Dredging

1. How does it influence the biological resource?

2. How does it effect hydrography (residence time, wave climate, loss of shoals, sediment budget)?

3. What is the frequency and intensity of sand mining/dredging that may be impacting park resources?

4. Is sediment quality improving or degrading over time?

Workgroup Summary Sheet

Impacts of Resource Extraction on Park Resources

What are the networks top three monitoring questions in priority order?

1. What are the effects of groundwater extraction on water tables (very significant), uplands, estruaries, wetlands and surface water availability?

2. How does coastal sand mining effect hydrography (residence time, wave climate, loss of shoals, sediment budget)?

3. What is the appropriate/acceptable level of shellfish harvest and how is this best determined?

If we can monitor only one or two vital signs for the network, what would they be?

1. Groundwater (level/salinity)

2. Sediment contamination

If we can monitor 3 or 4 vital signs, what would they be?

1. Groundwater (level/salinity)

2. Sediment contamination

3. Shoreline changes

4. Habitat response to shellfishing

Vital Sign Template

Management Issue: Groundwater Extraction

Monitoring Question Addressed: What are the effects of groundwater extraction on water tables (very significant), uplands, estuaries, wetlands and surface water availability?

Vital Sign: Changes in water table and salinity that differ from natural patterns of variation.

What ecosystem does this Vital Sign apply to:

Freshwater Wetlands, ponds, streams

Uplands: forest, grasslands, thickets

Why was this vital sign chosen?

- Easy to measure

- In many cases has been measured for a long period of time and has known variability

- Measurement is nondestructive

- Can be communicated to managers and to the public

Vital Sign Template

Management Issue: Resource Extraction

Monitoring Question Addressed: How does coastal sand mining effect hydrography (residence time, wave climate, loss of shoals, sediment budget)?What is the frequency and intensity of sand dredging?

Vital Sign: Bathymetry, shoreline change through GIS

What ecosystem does this Vital Sign apply to:

Beaches, dunes, spits, shoreline systems

Why was this vital sign chosen?

Meets almost all the features of an ideal indicator. It is anticipatory and non-destructive to measure.

Vital Sign Template

Management Issue: Resource Extraction

Monitoring Question Addressed: What are the effects of commercial and recreational shellfish harvesting on park aquatic habitats?

Vital Sign: Some measure of habitat disturbance to bottom habitat and associated communities (set up a control area (refuge) within the park for comparisons)

What ecosystem does this Vital Sign apply to:

Estuaries and Near Shore Environments

Why was this vital sign chosen?

- The effect is monitorable

- Information can be used to justify a management action

Other information

- Need to determine "threshold" values for disturbance

- Need inventory of state regulations describing allowable gear types

- Need to develop cause/effect relationship data describing disturbance per unit effort